AGRICULTURAL ENGINEERING

JULY • 1956

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A Performance and Operation-Cost Guide for Tile-Trenching Machines

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Systematic Method for Estimating Roughness Coefficients of Water Ways

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Breather Bag Provides Controlled Atmosphere Storage for Fruits and Vegetables

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Continuously Recording Soil Probe Speeds Evaluation of Soil Properties

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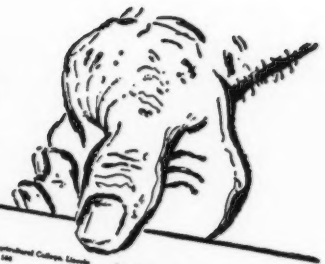
Methods for Evaluating Efficiency of Operations and Materials Handling

THE JOURNAL OF THE
AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

Case Engineering Scores Again with a Tractor That's Set a New

World's Record for Fuel Economy



Nebraska Test No. 566
Case 411

University of Nebraska Agricultural Engineering Department, Agricultural College, Lincoln
Copy of Report of Official Tractor Test No. 566

Dates of test: October 17 to October 28, 1955
Name and model of tractor: Case 411
Manufacturer: J. I. Case Co., Racine, Wis.
Manufacturer's rating: Not stated

BELT HORSE POWER TESTS
Fuel Consumption

H.P.	Check check speed R.P.M.	Gal. per hour	H.P. hr. per gal.	Lb. per H.P. hour	Water Cool. temp. Inlet	Water Cool. temp. Outlet	Temp. Deg. F. Air	Barometer Inches of Mercury
52.25	1498	4.491						
TEST B—100% MAXIMUM LOAD—TWO HOURS								
50.49	1500	4.446	11.46	0.517		0.00	178	58
TEST C—OPERATING MAXIMUM LOAD—ONE HOUR								
48.70	1500	4.282	12.78	0.481		0.00	178	58
TEST D—RATED LOAD—ONE HOUR								
46.92	1498	4.128	12.74	0.481		0.00	179	58
TEST E—VARYING LOAD—TWO HOURS (5 minute runs)								
1.98	1808	1.464	1.31	4.478			175	58
24.16	1805	2.668	5.31	4.685			175	58
37.54	1802	3.436	8.31	0.619			175	58
45.65	1499	3.958	10.91	0.513			175	58
51.83	1498	4.488	12.27	0.472			175	58
56.11	1503	5.048	12.89	0.464			176	56
		5.647	13.79	0.389			176	61
			10.48	0.520			174	
				0.577	0.00		175	60
							175	60

TORQUE (At Dynamometer)

Dyn. arm.	1485	1408	1397	1842	1178	1214	1006	858	854	801
Lb. in.	251.9	320.8	398.0	304.0	305.0	305.8	304.2	304.2	306.8	308.6
Rev. crnk.	1853	906	758	1791	679	857	1072	1323	1480	1637

DRAWBAR HORSE POWER TESTS

H.P.	Gear	Speed Miles per hr.	Engine Speed R.P.M.	Slip of Driving Wheels %	Fuel Consumption Gal. per hour	Fuel Consumption Lb. per H.P. hour	Water Cool. temp. Inlet	Water Cool. temp. Outlet	Temp. Deg. F. Air	Barometer Inches of Mercury
TEST B—RATED LOAD—TEN HOURS — 5th Gear										
35.80	5th	4.66	1601	4.43	2.996	0.840	180	50	88	28.165
TEST F—100% MAXIMUM LOAD										
55.89	3rd	4.80	1800	1.30	5th Gear					
TEST G—OPERATING MAXIMUM LOAD										
50.08	5th	4.97	1800	2.48	5th Gear				198	93
47.48	5th	3.49	1307	2.48	5th Gear					28.980
47.50	5th	3.70	1401	2.48	5th Gear					
41.90	5th	3.30	1305	2.48	2nd Gear (part throttle)		179	69	89	28.970
41.00	5th	3.70	1502	10.40	3rd Gear (part throttle)		178	72	91	28.970
40.18	5th	4.78	1505	7.50	4th Gear		181	74	89	28.970
37.55	5th	4.07	1503	5.04	5th Gear		182	76	89	28.960
36.66	5th	4.67	1504	3.80	5th Gear		184	76	89	28.960
	5th	14.15	1505	2.70	5th Gear		185	78	89	28.960
				1.78	5th Gear		185	78	89	28.960
50.85	1st	4.48	1808	11.83	5th Gear		182	81	89	28.930
							184	81	89	28.920
TEST H—OPERATING MAXIMUM LOAD										
55.58	1st	4.54	1500	10.40	5th gear (part throttle)		184	81	89	28.980

TRCL. WHEELS and WEIGHT Tests F, G & H

Rear Wheels	Type and Weight	Cast Iron	Test I	Test H
	Liquid Ballast		none	none
	Added Cast Iron	760 lb each	Cast Iron	Cast Iron
Rear Tires	Rim Size and Wg.	875 lb each	none	none
	Air Pressure	12-38 6-ply	12-38 6-ply	12-38 6-ply
Front Wheels	Type and Weight	18 lbs	none	none
(steel)	Liquid Ballast	Cast Iron	24 lbs	12-28 6-ply
	Added Cast Iron	None	Cast Iron	24 lbs
Front Tires	Rim Size and Wg.	None	None	Cast Iron
	Air Pressure	6.00-16 6-ply	None	None
Height at Drawbar		20 lbs	2 6.00-16 4-ply	2 6.00-16 4-ply
Static Weight	Rear End	20 lbs	20 lbs	20 lbs
	Front End	7600 lbs	45 inches	88 lbs
	Total	1825 lbs	4316 lbs	818 inches
Total Weight as Tested (With operator)	Rear End	9410 lbs	1800 lbs	4100 lbs
	Front End		6019 lbs	1825 lbs
	Total			6100 lbs

FUEL, OIL and TIME—Fuel: Gasoline, octane No. ASTM 80.5, research 85.9 (rating taken from oil company's typical inspection data); weight per gal. 6.125 lb. Oil: SAE 10; 1.682 gal. Total time motor was operated: 64½ hours.

CHASSIS—Type: Tricycle. Serial No. 5967066. Tread width: Rear 52" to 88" front 51⅜" to 75⅛". Wheel base: 92½". Hydraulic control system: Direct engine drive with independent. Power take-off: Direct engine drive with throw-out lever. Advertised speeds, mph: First 1.26, second 1.84, third 2.66, fourth 3.88, fifth 5.66, sixth 8.26, seventh 8.44, eighth 13.66, reverse 1.78 and 6.22. Belt pulley: Diameter 10", face 7⅛", rpm 1166; belt speed 3208 fpm. Clutch: Single plate dry disk, 9208 fpm. Clutch: Single can be tilted upward, suspended by foot pedal. Flexible rubber in front cushion. Rear axle: Semi-floating, suspended by adjustable pedals. Brakes: Double disc, differential shaft operated by two foot pedals, equalized by locking foot pedals together. Power take-off: Continuous running with independent clutch.

ENGINE—Make: J. I. Case. Type: 4-cylinder vertical. Serial No. 8067068. Crankshaft mounted lengthwise. Head: I. Lubrication: Pressure. Governed rpm: 1800. Compression ratio: 6.6:1. Rated rpm: 1800. Compression stroke: 6"x6". Displacement: 251 cu. in. Port diameter: Inlet 1⅝", exhaust 1⅝". Valve lift: Inlet ⅜", exhaust ⅜". Piston speed: 1800 fpm. Governor: Variable speed centrifugal. Carburetor: Make: Zenith. Carburetor size: 1⅛". Ignition system: Battery. Starting system: Delco-Remy. Battery: Air cleaner: Oil-washed. Replaceable treated paper element. Cooling medium: Pressurized. Thermostat. Radiator temperature control: Thermostat.

REPAIRS and ADJUSTMENTS—No repairs or adjustments.

REMARKS—All test results were determined from observed data and without allowances, additions or deductions. Tests B and F were made with carburetor set for 100 percent maximum belt horsepower. Tests C, D, E, G, H, J and K were made with an operating setting of the carburetor (selected by the manufacturer) of 94.3 percent of maximum belt horsepower.

Rapid variations in engine speed occurred intermittently during the early morning part of test H.

HORSEPOWER SUMMARY

	Drawbar	Belt
1. Sea level (calculated) maximum horsepower (based on 60° F and 29.92" Hg.)	47.21	54.74
2. Observed maximum horsepower (tests F & H)	44.89	53.25
3. Seventy-five percent of calculated maximum drawbar horsepower and eighty-five percent of calculated maximum belt horsepower (formerly ASAE and SAE ratings)	35.41	46.53

We, the undersigned, certify that this is a true and correct report of official tractor test No. 566.

L. F. Larson
Engineer in Charge

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Case engineers . . . dedicated to the objective of giving farmers a 4-plow tractor without equal in performance, power and economy . . . have climaxed their efforts in the new 8-speed Case "400." Evidence of this achievement rests in recent, impartial Nebraska tests. Results show conclusively that the Case "400" is the all-time champion for low fuel consumption. With its Case-designed Powrdyne engine, more power was produced per pound of gasoline than any other tractor in the whole history of these official trials.

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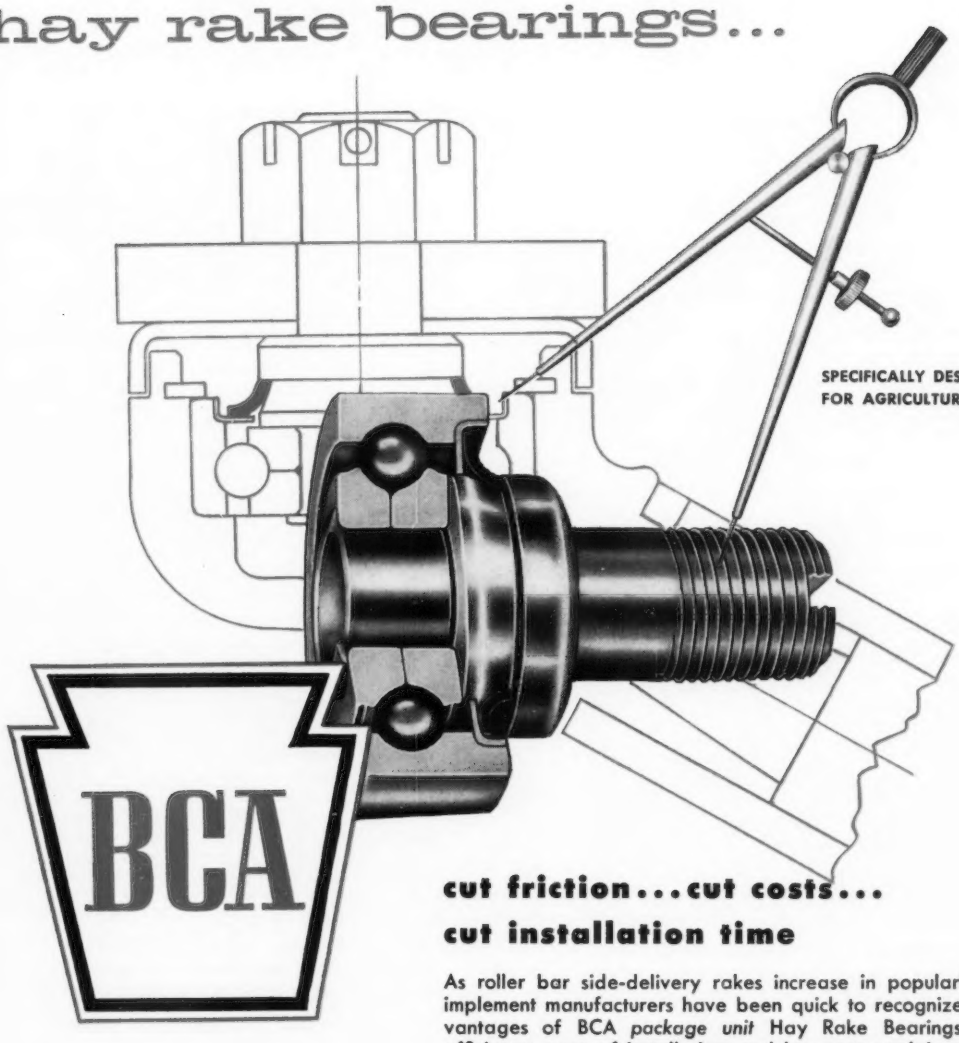

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AGRICULTURAL ENGINEERING

Established 1920

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GM GENERAL MOTORS

HYATT ROLLER BEARINGS

1. DISTRIBUTION OF LOAD WITHIN THE BEARING

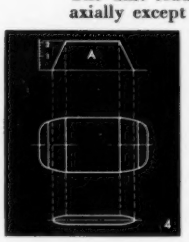
Rollers are subjected to load only while in the "load zone," with maximum load while on the line of action of the bearing load, as shown in diagram 1. The theoretically perfect "load zone" extends from −90° to +90° from the line of action, but this is neither practical nor necessarily desirable. Under normal loadings, the actual "load zone" may range from 90° to 120°, depending on load and mounted internal clearance. This distributes the load so the load on the heaviest-loaded roller is approximately 5/N times the bearing load, where N is number of rollers.

2. DISTRIBUTION OF LOAD WITHIN ROLLER'S AREA OF CONTACT

A cylinder deflects locally in the region of engagement when loaded between flat plates. The plate also deflects, so the original line of engagement is broadened into a "dog-boned" area under load, as shown in diagram 2. Moreover, deflected cylinders must gather in metal at their ends in *two planes, and this end-loading effect can seriously reduce the life of a cylindrical roller bearing.* All HYATT rollers have generous corner radii or blended chamfers to reduce end effect; and all HYATT Hy-Load rollers also have crowning to allow the contact area to "fade out" evenly (diagram 3).

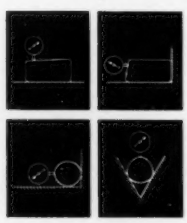
3. DISTRIBUTION OF LOAD ACROSS ROLLER

The unit load on any roller is uniformly distributed axially except at the crowned ends where it drops off to zero as shown in diagram 4. The summation of unit loads represented by area A is the total roller load. This same load under misalignment results in an area equal to area A; but maximum unit load is considerably greater and the bearing will have a shorter life than a properly aligned one. When the same total load is applied to an *uncrowned* roller, an even higher unit load results. This demonstrates the value of crowning when misalignment occurs.



4. EFFECT OF ROLLER QUALITY ON BEARING PERFORMANCE

Lack of roller quality control has a very adverse effect on performance: 1. A roller with excessive *taper* tends to uneven load distribution and abnormal temperature rise. 2. A roller with excessive *end square* tends to noisy bearing performance. 3. A roller with excessive *two-point out-of-round* tends to poor segregation and poor bearing life. 4. A roller with excessive *three-point out-of-round* tends to noisy bearing operation. 5. A roller with *poor finish* tends to wear on all operating surfaces and noisy operation. 6. A bearing with excessive *roller-to-roller diameter variation* tends to poor bearing life. 7. A bearing with excessive *roller-to-roller length variation* tends to poor thrust capacity, abnormal temperature rise.



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New peanut combine harvests

Four Dayton V-Belts power main drive of new Lilliston

Traveling along windrows at 3–5 mph, the new Peanut Combine manufactured by The Lilliston Implement Co., Albany, Georgia, is setting harvesting records that are almost unbelievable. Averaging an acre an hour, this amazing combine is fast replacing the old, costly, time-consuming method of harvesting "by hand," which required eleven men. Now, with Lilliston-mechanized harvesting, only two men are required, saving farmers up to 80% in labor costs, or approximately $40 per acre.

Even more important, harvesting can now be completed early in the fall when the weather—and the price—is right. There's no waiting for hard-to-get manpower, and harvesting itself takes a comparatively few days. Because of speedier harvesting, land is cleared and ready for other crops 60–90 days earlier than ever before. Nuts grade higher, too, because of Lilliston's special carding and picking principle.

Compact and maneuverable, the combine is powered by a 25 hp air-cooled engine mounted well up out of dust and dirt.

Dayton V-Belts and Dayton engineering assistance are saving money for Lilliston on every combine. Originally the Main Drive was equipped with six wrapped V-Belts, but Lilliston engineers felt that necessary power could be transmitted more economically. Dayton V-Belt engineers were asked for a recommendation. After a study of the horsepower requirements and other factors involved, Dayton engineers were able to show Lilliston how to transmit the same power, which was demanding six belts, with only four "B" section Dayton V-Belts. This could be done because of Dayton V-Belts' greater strength and durability.

After rigorous tests, Lilliston enthusiastically approved Dayton's four belt drive for the peanut combine. So well have Dayton V-Belts proved themselves in actual field operation that all Lilliston Peanut Combines are now 100% Dayton-equipped.

an acre an hour

peanut combine

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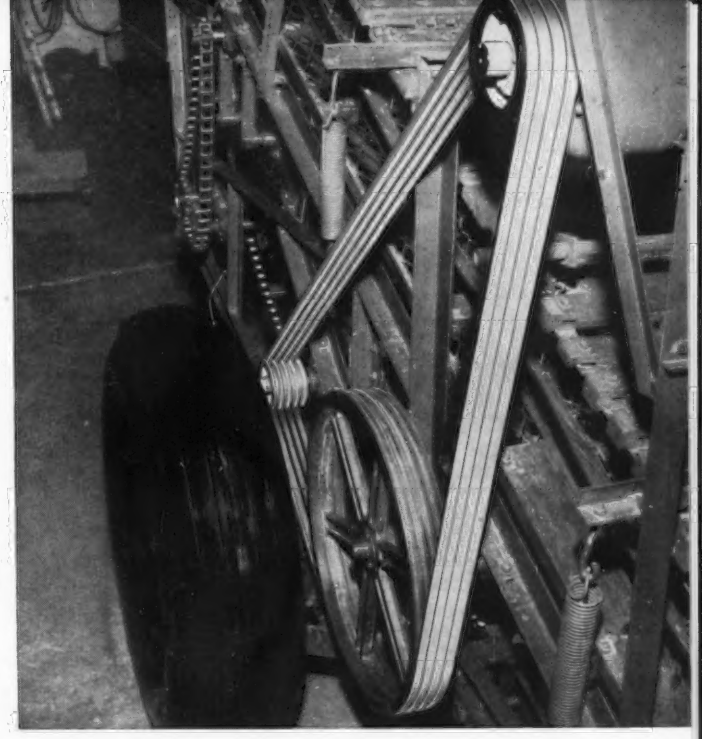

Transmitting full uniform power to the Main Drive on Lilliston's new Peanut Combine are four perfectly matched "B" section Dayton V-Belts. The multi-ply construction, with special super-strong rayon cords, gives them the extra strength which, in the case of Lilliston's Peanut Combine, enables four Dayton V-Belts to do the work of six ordinary belts.

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without altering design, sprockets or performance

Corn picking is one of the tougher services chain encounters in the implement field, and John Deere uses Link-Belt "AG" chain for its Two-Row Mounted Picker. Besides F attachment shown, others are available for specific conveying jobs.

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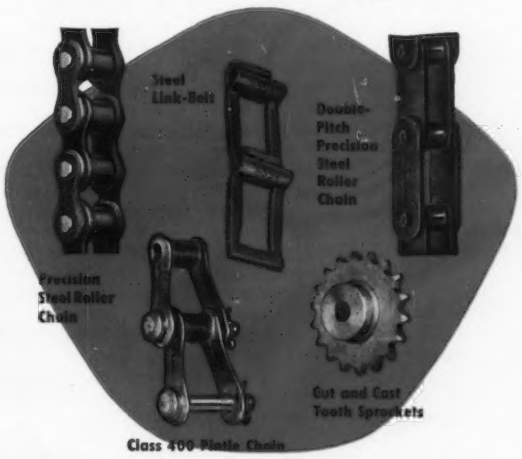
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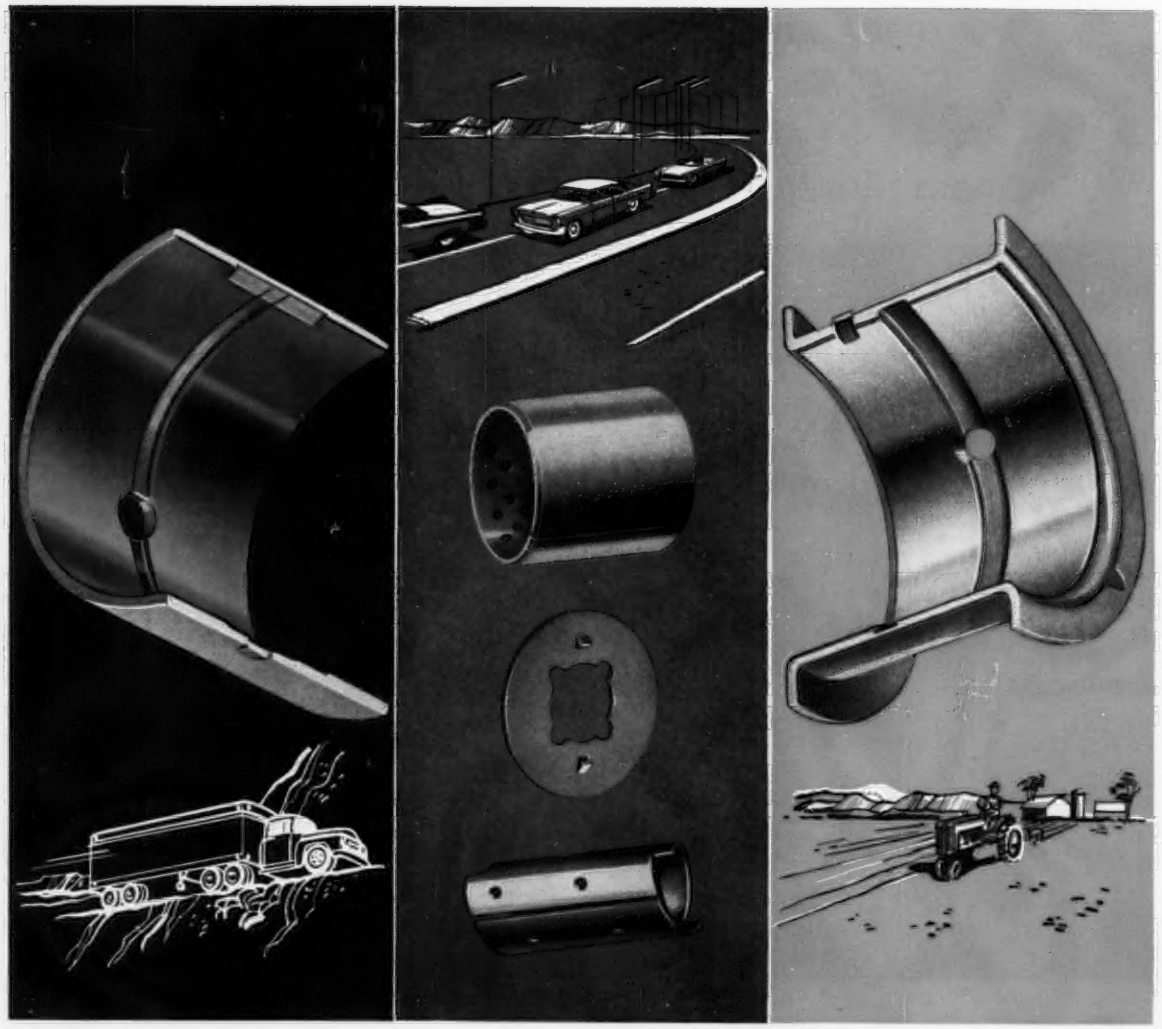

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FEDERAL-MOGUL DIVISION

FEDERAL Mogul

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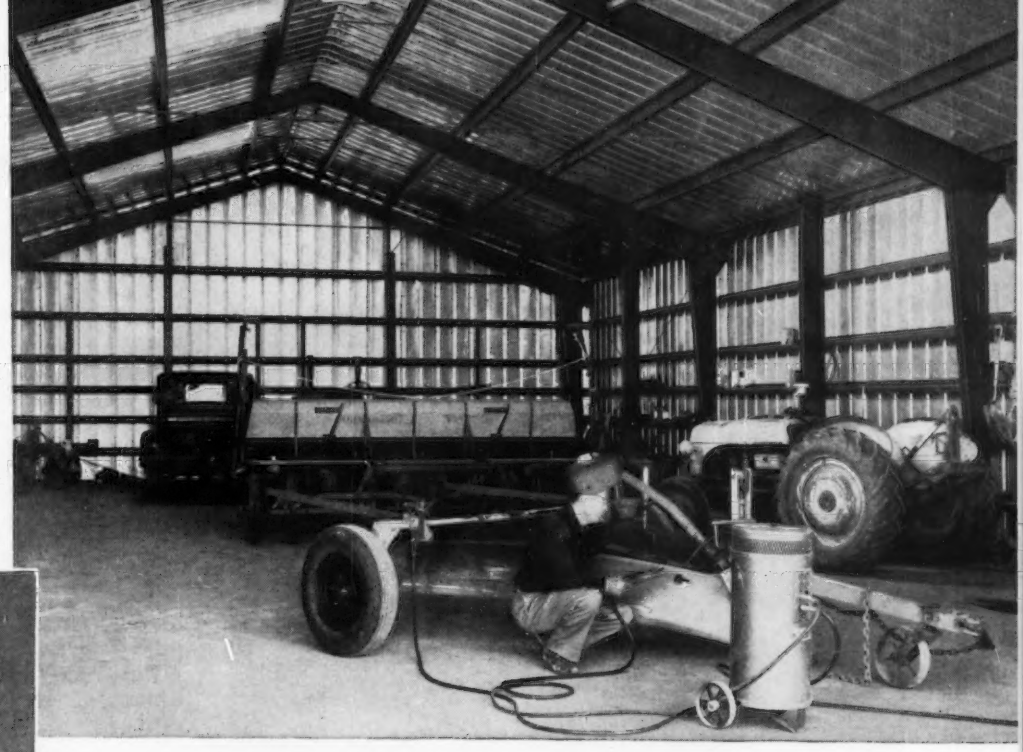

"THIS STURDY, convenient building is ideal for grain storage, machine shelter and shop facilities," says F. M. Greathouse of Garden City, Kansas. "I'd recommend it to any farmer in Kansas, or any other state for that matter. Its great structural strength permits piling grain 11 ft. high, is adequate for overhead crane for pulling motors. This building should last a lifetime, with a minimum of care. It's mighty good-looking too."

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USS MAN-TEN Steel has higher strength with a yield point one and one-half times that of plain carbon steel. That is why the Butler Manufacturing Company, Kansas City, Mo., is making generous use of USS MAN-TEN in purlins, girts and eave struts in their steel farm buildings. For, by using high strength steels in these members, they are able to obtain more effective strength per dollar—greater economy than with any other material.

Here is what Butler Manufacturing reports: "We originally started making these purlins of 14-gage carbon steel, which — when properly spaced—carried a roof load of 15 lbs. per sq. ft. They weighed 62 lbs. each.

"As our business expanded, there was a need to furnish buildings capable of carrying heavier roof loads, so we turned to high strength steels. Now, made with 14-gage USS MAN-TEN Steel, our purlins weigh no more than before, but can support a load of 26 lbs. per sq. ft. To obtain this greater strength with carbon steel would require a member weighing some 93 lbs.

"We figure that on an average size Butler farm building—40 x 60 x 14—the saving of 31 lbs. per purlin results in a saving of 1600 lbs. of steel. This not only makes erection easier but materially reduces freight costs on the steel as well.

"To this can be added important savings in steel costs. The MAN-TEN Steel eave struts, for example, cost 83 cents less per piece—and purlins cost 97 cents less."

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"Sugar field equipment gets the toughest use and abuse of any agricultural machinery. For utmost dependability in vital chain drives and couplings in any equipment we make, we specify Morse."

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Sugar field machinery *must* "take it," for a breakdown can mean serious crop loss. Used under the worst possible conditions of weather and terrain, it is subject to unusually severe wear.

Significantly, Thomson Machinery Company, world's largest producer of this specialized equipment, specifies Morse wherever they employ chain drives, sprockets, and couplings. Since 1942, they have depended on Morse quality exclusively—have never had a Morse Chain failure on their equipment.

Morse makes a complete line of roller chain, featuring a complete selection of special attachments for agricultural equipment. Morse engineers are foremost in developing special-purpose chains; have led in keeping pace with changing agricultural requirements for years.

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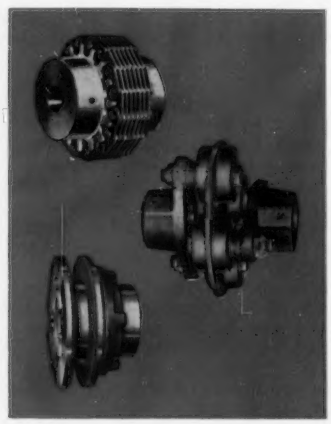

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Morse Roller Chain Drive. Special double pitch chain, mock-up showing variety of special attachments.

Morse Silent Chain Coupling, Morflex Flexible Coupling, adjustable Morse Torque Limiter.

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POWER TRANSMISSION PRODUCTS

How Armco Stainless Steel can help you with your sprayer design problems

Today's farm sprayers must be constructed to meet more rugged service than ever before. This is why:

1. **Increasing use of liquid fertilizers.**
2. **Greater use of insecticides, fungicides, herbicides, and other pesticides.**
3. **More emphasis on concentrate sprays.**

These trends mean more annual hours of sprayer use with chemicals that are often highly corrosive. One way to assure long, trouble-free service life in your sprayer equipment is to use Armco Stainless Steel for vital parts.

This farm sprayer has stainless steel in all parts that come into contact with corrosive spray materials.

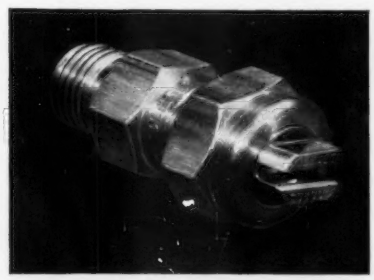
RESULTS OF TESTS

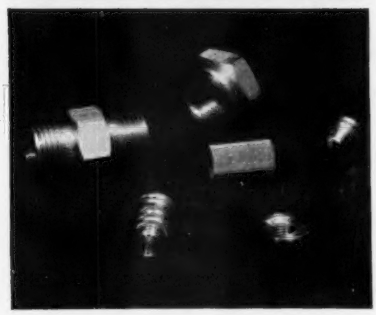
Here are the findings of three independent agencies that made tests with stainless steel:

U. S. Department of Agriculture reports, "Types 304 and 316 stainless steels were highly resistant in all tests" conducted with a variety of pesticides.

Aircraft Research Center, Texas Engineering Experiment Station, reported, "In the partially submerged tests, Type 302 stainless steel demonstrated complete resistance to corrosion throughout the test period." (In atmospheric tests Type 302 stainless steel exhibited excellent resistance, with a very slight metal damage observed in the case of only one of 30 formulations tested.)

University of Manitoba, Winnipeg, Canada, exposed 21 metal samples to six pesticides. Stainless steel showed "no change" in all solutions.





Stainless steel in all nozzle parts helps maintain proper operation and long service life.

MAINTAINS ACCURATE DIMENSIONS

By using Armco Stainless Steel in sprayer nozzles, for example, you don't have to worry about corrosion either enlarging or stopping up nozzle orifices. You can select a grade of stainless for these parts that combines corrosion resistance with high hardness. Then with stainless steel strainers to keep foreign matter from clogging openings, you can design for accurate metering over a longer period.

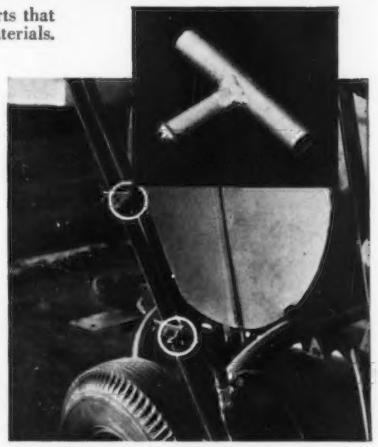
Other vital sprayer equipment parts where Armco Stainless Steel provides long service life are flow control, pressure regulating, by-pass, shut-off, check, and safety valves, as well as pumps, tanks, and tubing.

ASSURES TOP-NOTCH OPERATION

Armco Stainless Steel in these parts will help you design sprayers that assure your customers proper operation for a longer time. Stainless protects against corrosion that could change delivery rates, thus waste costly chemicals, or damage crops by spraying too little or too much.

WRITE FOR INFORMATION

For complete information on Armco Stainless Steels, just fill in and mail the coupon. Armco engineers are ready to work with you in determining the stainless steel grades that will meet your requirements.



Stainless steel nozzles can be threaded to fit into frame sections of sprayers. Here, hoses fit over stainless tubing welded to nozzles. Hose clamps are also stainless steel.

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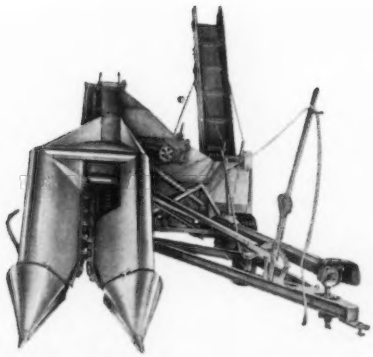

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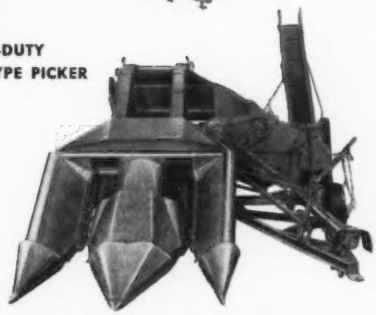

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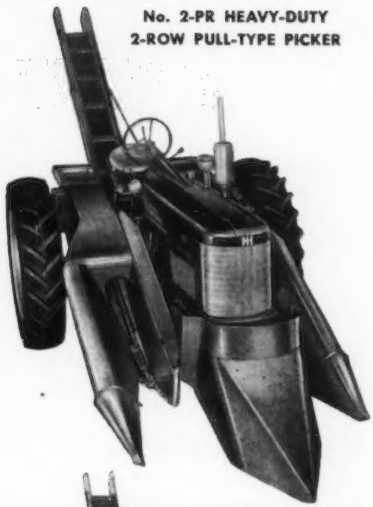

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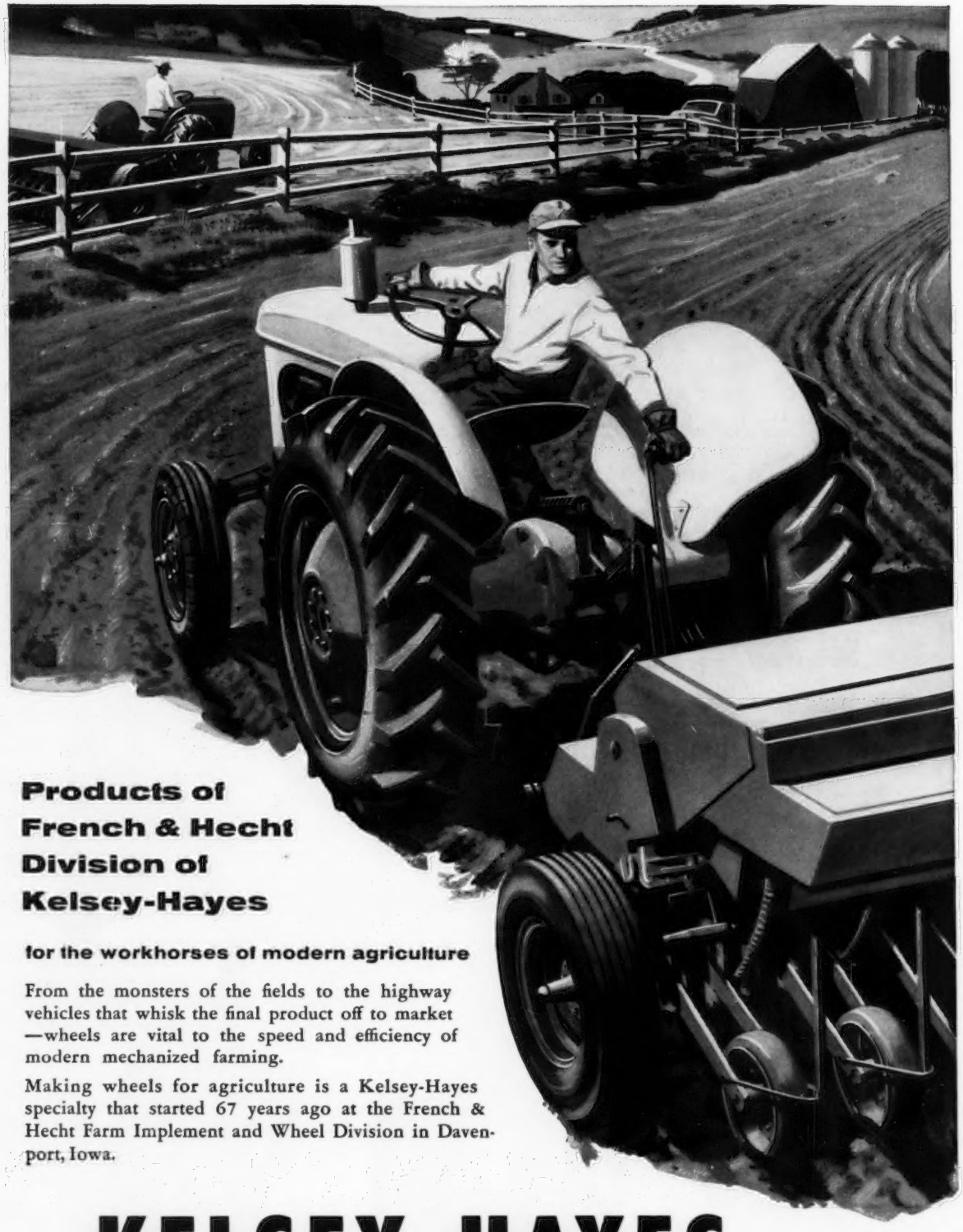
2C-10 LOW-COST
1-ROW MOUNTED PICKER



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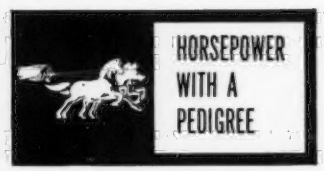

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For more than half a century the engineering resources and creative energies of Clark Equipment have been focused on this Vital Area of machine performance: Engine Power Transmission.

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Among equipment builders cashing those benefits is Clark itself, through its own end-product machines: fork-lift trucks, straddle carriers, industrial towing tractors and powered hand-trucks for materials handling; and tractor shovels, turbo-dozers and excavator cranes for the construction industry. No user is more appreciative of those benefits than Clark, nor recognizes them more clearly as inevitable results of unique experience and straight thinking.

For this is the new approach by modern engineering: To think not of component units, no matter how skilfully assembled—but rather in terms of a complete, integrated power-train of functional design to do a bigger job better and cheaper.

You can say this now of a growing number of modern machines—our own and others, for agricultural and industrial uses:

- From engine flywheel to point of torque application—power train designed and manufactured by Clark Equipment.

It's a vital step, yet easy, toward basic improvement of your product—and costs not a cent: Arrange to talk "Power Transmission" with the engineers of Clark. Write a letter.

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the Answer to the 64-DISC Question:

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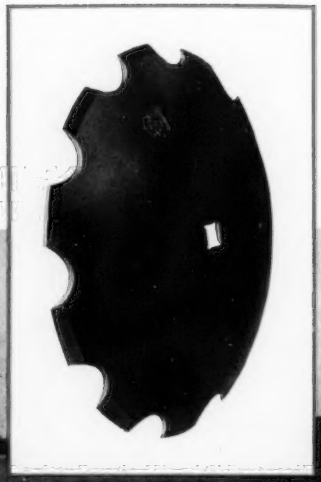

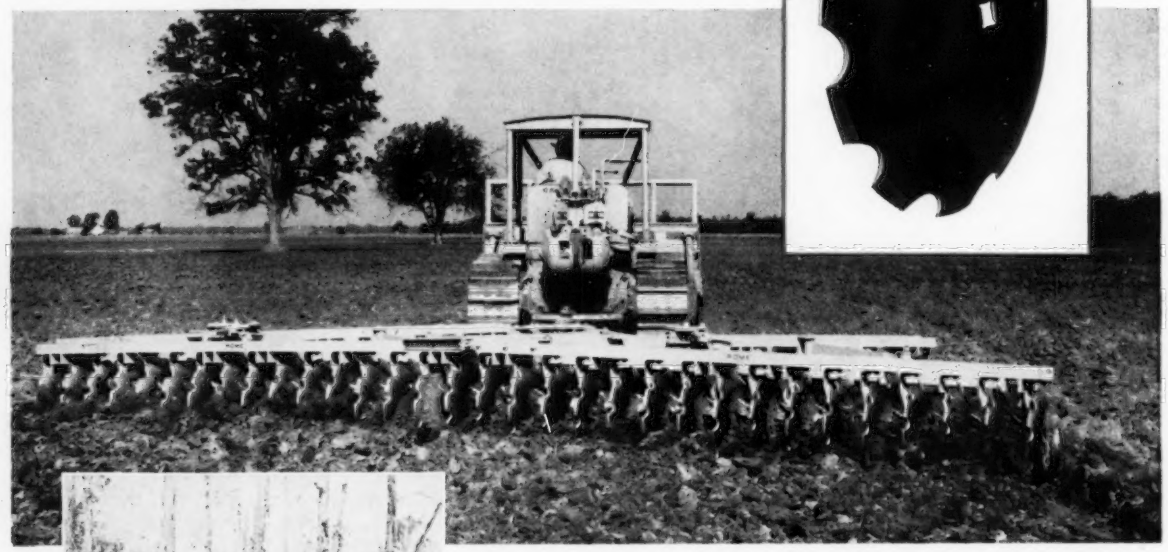

Ingersoll Dura-Notch discs team up with a special Rome plow to chop up heavy brush

When it comes to discs for its 25′ Hinge Type Offset Harrow squadron, Rome Plow Company finds the answer in 64 big, husky Ingersoll Dura-Notch discs. For special purpose disc plows, too—such as shown at the left—Rome also specifies Dura-Notch.

It's easy to see why. Dura-Notch discs team up with heavy duty equipment to tear into tough chores, make quick work of large acreage, keep going without failure.

That's because they're *made* tougher to *be* tougher, through and through. And the big reason is right in the notches. Ingersoll makes them by an exclusive patented method that completely eliminates the need for grinding the cut-out. So they're extra strong—far more resistant to heavy impact.

What's more, Dura-Notch discs are made of Tem-Cross® steel . . . Ingersoll's special steel that's *cross*-rolled for top resistance to splitting, curling and abrasion. And they're specially heat-treated and tempered for just the right hardness without brittleness.

Made only by Ingersoll—to your own implement maker's specifications, for both original equipment and replacement use. So—to be sure you get Dura-Notch quality for *your* customers, order them direct from your implement manufacturer.

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AGRICULTURAL ENGINEERING

VOL. 37 JULY, 1956 No. 7

Tile-Trenching Machine Performance

G. O. Schwab, R. K. Frevert, and L. L. DeVries
Member ASAE Member ASAE

FOR all but some small jobs and for occasional adverse soil and climatic conditions, the tile-trenching machine in most areas has largely replaced hand methods of tile installation. Although a tile-trenching machine (assuming a crew of three men and a depth of 4 ft) can install about four times as much tile as three hand tilers, such a machine must not only install a considerable amount of tile to justify the large investment involved, but it must be managed so as to provide the maximum accomplishment with a minimal cost. Some of the problems relating to the performance and operation of tile-trenching machines are discussed in this paper.

Data on performance and operating costs of tile-trenching machines, gathered over a four-year period, provide valuable aids in evaluating the economics of machine tiling.

Requirements of a Tile-Trenching Machine

A tile-trenching machine should fulfill the following desirable functional requirements:

- Operate efficiently in a variety of soil conditions
- Have ample wheel or track area in contact with the soil so as to operate on relatively soft ground
- Dig accurately to grade, especially in non-uniform soils
- Have a power-driven device for maintaining grade which is easy to control, positive in action, and capable of lifting the digging mechanism from the trench in sticky or caving soil
- Provide a V-shaped or curved bottom with an alignment groove (keel) in the trench so that ordinary bedding conditions (load factor 1.5 based on the three-edge-bearing test) are obtained
- Cut a trench to grade with one pass of the ground
- Excavate a trench wide enough to allow sufficient side clearance to insert the tile without delaying machine operations
- Place the spoil far enough away from the machine so that it does not roll or fall back into the trench
- Start a trench from an open ditch
- Start a lateral drain from another tile line with a minimum of hand labor
- Dig a trench as close as 20 ft to or from a fence line or other obstruction
- Turn a curve with a radius of 300 ft (about a 19-deg curve)
- Operate for long periods of time without breakdowns or recurring mechanical failure
- Be provided with a safety clutch or breakpin on the digging mechanism
- Be moved easily and quickly from job to job
- Be put into operation easily and quickly after reaching the job site.

General Classes of Trenching Machines

According to Yarnell (6)*, tile-trenching machines may be divided into four general classes as illustrated in Fig. 1: *(a)* wheel-type machines, *(b)* endless-chain excavators, *(c)* hoe (scraper) excavators, and *(d)* plows and scoops. The wheel and endless-chain excavators are by far the most common. Hoe excavators include machines of the hoe and dragline type. They are suitable for making deep cuts or for installing large-size tile. Plows and scoops may be pulled through the trench to loosen the soil, or the machine may carry the soil out of the trench. These machines require several trips through the trench to excavate it to grade. Generally they are not suitable where the soil is extremely dry, where the sides of the trench are subject to caving, and where the depth of cut is in excess of 3 or 4 ft.

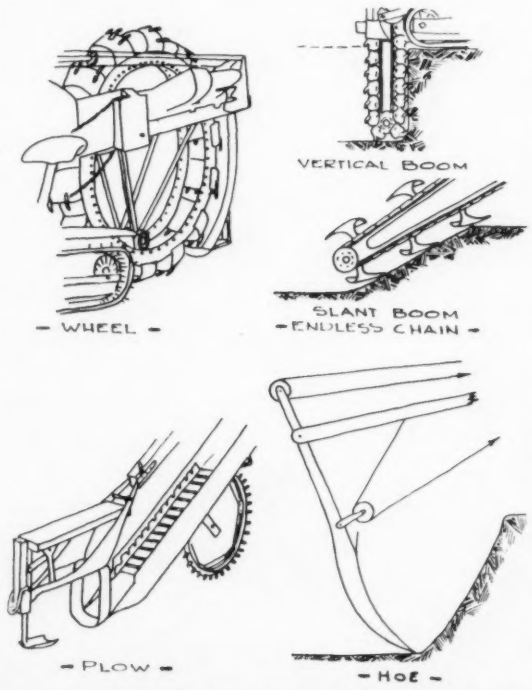

Fig. 1 General classes of trenching machines. Modified from Beach (1)

Source of Data

The data presented here were obtained during the 4-

Paper presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1955, on a program arranged by the Soil and Water Division. Approved for publication as Journal Paper No. J-2883 of the Iowa Agricultural Experiment Station, Project Nos. 1003 and 1038.

The authors—G. O. SCHWAB, R. K. FREVERT, and L. L. DEVRIES—are, respectively, professor of agricultural engineering, Iowa State College; assistant director, Iowa Agricultural Experiment Station; and former graduate student in agricultural engineering, Iowa State College.

Acknowledgments: The authors wish to express their appreciation to W. E. Beach and J. van Schilfgaarde for their contributions and to the drainage contractors who cooperated in the study.

*Numbers in parentheses refer to the appended references.

year period (1947-51) from a series of field observations of wheel and endless-chain trenching machines and from questionnaires sent to contractors. Light-weight machines mounted on tractors or wheeled vehicles were not included in this study. Several machines produced by four prominent manufacturers were observed in Iowa and southern Minnesota. For a period of three years, accurate records were kept on the operational cost of one wheel-type machine. In 1950 a "service recorder" was placed on this machine for the purpose of determining the extent and causes of time loss. Questionnaires sent to contractors were returned by 45 operators in 1947, 49 in 1949, and six in 1951.

Rate of Installation

Factors Affecting the Rate of Installation. The factors which influence the rate of installation of tile-trenching machines include: depth and width of the trench, characteristics of the machine, soil and moisture conditions, skill of the operator, and size and efficiency of the crew. The depth of installation is generally more important than the width of cut. Heavy machines with large power units probably have less reduction in digging speed with depth than lightweight machines, especially those with small power units. Characteristics of the machine which influence the rate of installation are the make, age, and mechanical condition. Buckets or teeth on the digging mechanism which are bent or badly worn result in greater power consumption and lower efficiency. Soil properties which influence the rate of installation are moisture content, hardness, cohesiveness, texture, structure, and condition of the soil surface. Although vegetation normally has little effect, large roots or dense plant cover may cause delays by clogging the digging mechanism. The skill of the operator is very important, *e.g.*, good judgment is required in selecting the proper digging speed for the machine. Operating a machine in a gear slower than necessary may reduce the daily output by several hundred feet. The skill and efficiency of the crew is likewise important in reducing unnecessary time loss.

Continuous Rate of Digging. The rate of continuous digging for 10-min periods was observed for several makes of machines in many soil conditions. More complete data were recorded for a selected wheel-type machine listed as machine A in Fig. 2. The performance data of each machine observed are given in Fig. 2. For the observations in a relatively uniform Webster soil in the same field for this selected wheel-type trencher, all soil and machine variables except the digging speed and the depth were held as nearly constant as practical. For these conditions the solid dots in Fig. 2 show the results for this machine at depths varying from 2.7 to 5.2 ft. The best fitting curve for these observations as reported by DeVries (2) is represented by a third-degree polynominal equation. By statistical analysis DeVries (2) found that 83.1 percent of the variation of the data is due to the depth. For the same data a linear regression line accounted for 67.8 percent of the variation. There is a concentration of solid dots at the 450 fph and at the 200 fph rate. At each of these two speeds the machine has two gears which give nearly the same ground speed. Since these concentrations of data are a characteristic of the machine, it is doubtful that the third-degree curve gives a more accurate depth-speed relationship for all makes of machines and all soils than the linear equation. Observations by Ohlson (4) indicate that from about 2.6 to 3.9 ft the depth did not affect the speed appreciably, but where the depth varied from 3.9 to 5.5 ft, the rate of digging decreased with increasing depth.

If all observations are analyzed statistically for the four makes of machines in all soil conditions, the rate of digging *(Y)* as a function of the depth *(X)* can be represented by the linear regression equation, $Y=768-114X$. Of the 100 observations shown in Fig. 2, the range in digging speed varied from 90 to 960 fph. Although no attempt was made to eliminate variables other than depth, except for the one machine, the data for the different makes of machines did not differ significantly. Therefore, the linear regression curve, $Y=768-114X$, does not include differences among the machines. Because the data for all observations include machine, soil, and other variables, which were eliminated from the observations on the one machine, only 33.8 percent of the variation of digging speed with depth is explained by the linear equation. Although the width of cut varied slightly for different machines, a trench for 4, 5, or 6-in tile was dug in practically all instances. Other causes for variation in the data may be attributed to soil texture, moisture content, mechanical condition of the trenching machine, or other factors. While no attempt was made in this analysis to evaluate the effect of these factors, earlier studies by Beach (1) indicated that soil texture, moisture content, and soil hardness were of only minor importance in comparison to the effect of depth on digging speed.

Time Loss. Continuous digging rates do not represent the daily or even the hourly capacity of a machine since delays in operation are not taken into account. Accurate records of the time loss for the selected wheel-type machine during a season of operation are indicated in Fig. 3. Of the

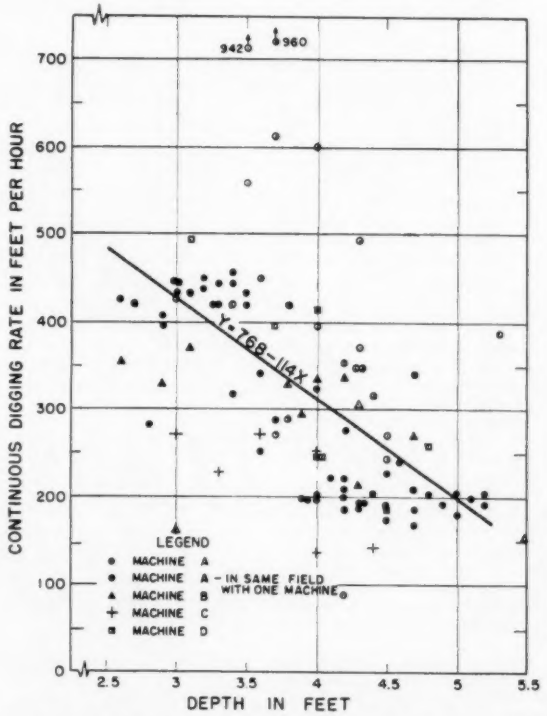

Fig. 2 Effect of depth on continuous digging rates for tile-trenching machines

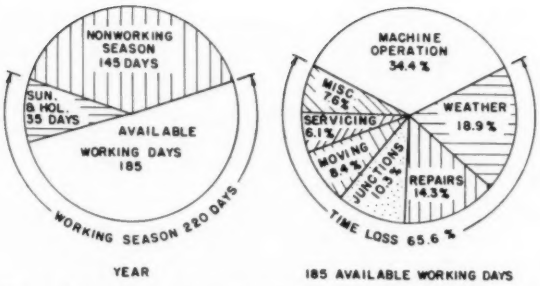

Fig. 3 Annual use and time loss for a tile-trenching machine operating in Iowa and southern Minnesota

220 days during the working season, there were 185 available working days and 35 Sundays and holidays. If an additional 35 days (185 x 18.9 percent) are lost due to weather, only 150 days are available for operating the machine. Results from questionnaires indicate that 150 days annual use is about average for trenching machines in Iowa and Minnesota. Ohlson (4) in Sweden also based his cost estimates on 150 days annual use.

The distribution of the 185 available working days is indicated in Fig. 3. The machine was actually operating only 34.4 percent of the time; the remaining 65.6 percent is time lost due to weather, repairs, junctions, moving the machine, servicing, and miscellaneous items. Other investigators have found that the time loss is quite high. For example, Yarnell (6) reported that the time loss for 15 machines operating in New York during 1918 was about 60 percent not including time loss due to weather.

Daily Rates of Digging. If it is assumed that 65.6 percent of the time is lost, the rate of digging per 8-hr day based on the regression equation shown in Fig. 2 is 1,170 ft at a depth of 3 ft, 860 ft at a depth of 4 ft, and 545 ft at a depth of 5 ft. In Sweden, Ohlson (4) found that the average rate of installation per 8-hr day for soils of different texture was a follows: Clay-moraine, 525 ft per day; very heavy to medium clay, 1,170 ft per day; light clay and sand, 1,430 ft per day; and peat, 1,610 ft per day.

Cost of Operation

The cost of operation for ditching machines during the period 1947-51 was obtained by a survey of contractors and from accurate records for one wheel-type machine over a period of three years. The average annual use in days and the feet of digging per season, respectively, from the questionnaire were 133 days and 124,000 ft and for the one machine 164.5 days and 177,300 ft. Thus, the one machine on which records were kept was in use considerably more than the average.

The cost of operating tile-trenching machines may be divided into fixed and variable costs. The average cost of operation for a 3-year period for the one machine is indicated in Fig. 4. The percentage of the total operating cost and the cost per lineal foot are indicated for each item. The average total cost of operation per season was $16,311, the cost per day $100.40, and the cost per foot 9.3 cents.

Fixed costs represented 28.2 percent of the total. In this analysis the depreciation was computed by the straight-line method using an average life of 5 years and 10 percent of the original cost as the salvage value. The results of the questionnaire indicated that the average machine life was 7.5 years, which is somewhat higher than 6.16 years as used by Ohlson (4) in his analysis. The interest charge was computed at 6 percent on the average investment. Insurance and taxes include property tax and fire, tippage, and theft insurance, as well as liability insurance. The charge for management includes such services as surveying and mapping, supervision, bookkeeping, and collecting accounts. The charge for management was arbitrarily set at $300 per month for 9 months.

The variable costs which represent 71.8 percent of the total include labor, fuel, repairs, transportation of personnel, and moving of the machine from job to job. The charge for labor includes servicing and operating the machine, laying and blinding the tile, and minor repair work. In addition 1.5 percent of the gross payroll is included for employment tax and 3.32 percent for workmen's compensation insurance. For this analysis a crew of four men was used most of the time, but only three were available part of the time. The questionnaire indicated similar results, that is, an average size crew of 3.3 men. The cost for fuel also includes lubricating oil and grease. The repair cost consists of the charge for parts, freight, and labor not performed by the crew. The total repair cost for the one machine was $2,077 as compared to the average of $2,300 as determined by the 1951 questionnaire. Contractors who do not keep accurate records apparently underestimated their repair cost as much as 60 to 70 percent of the actual cost. Transportation charges include travel for taking the crew to work, for planning and surveying, in collecting bills, and for obtaining repairs. The rental trucking charge for moving the machine within a radius of 30 miles averaged about $25 per move.

The effect of footage per season on the total annual cost of operation and the unit cost per foot for the above conditions is given in Fig. 5. The greater the annual use, the less the cost per foot. For example, increasing the footage from 14,000 to 200,000 ft per year will reduce the cost per foot from 40 to 8.79 cents.

It should be remembered that the costs presented here are for the period and conditions of these observations. Costs could be considerably higher or lower, depending upon climatic and economic conditions. Also, the costs presented do not make any allowance for profit to offset the financial risk involved.

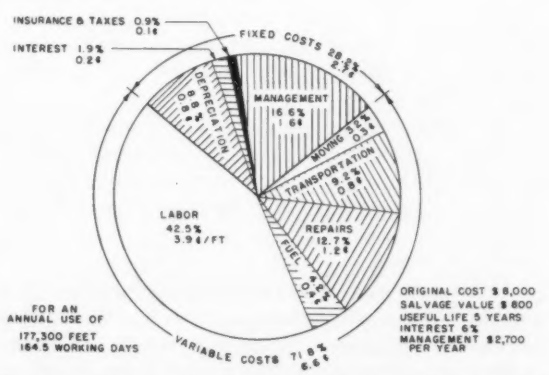

Fig. 4 Operating costs for tile-trenching machines. (Upper number shows the percent of the total cost, and the lower number is the cost per lineal foot.)

Charging for Overdepth

A comparison of different methods of charging for overdepth is shown in Table 1. The most common method in use is a constant charge for each increment of overdepth as shown in the last column of the table. These prices are based on a charge of $14.00 for 4-ft depth and 10¢ per lineal foot per foot of overdepth below 4 ft. The relative charge based on the capacity of the machine (Fig. 2) is taken as 100 percent at the 4-ft depth. The resulting relative charge at 3.0 ft is 73 percent and at 5.5 ft 221 percent. Because of the possibility of more time loss and wear on the machine at greater depths, a charge higher than that based on the capacity of the machine may be justified. The relative charge at a depth of 3 ft, based on the data in this study, is 27 percent less than at 4 ft, but many contractors in Iowa and Minnesota have the same price for depths less than 4 ft. Since soil variations may have considerable effect on digging speeds and time loss, it is difficult to make specific recommendations in charging for overdepth. As indicated in Table 1, for depths over 4 ft, a constant charge of 10¢ per lineal foot per foot of overdepth is within 11 percent of the prices computed in column 3, which are based on continuous digging rates in Fig. 2.

TABLE 1. COMPARISON OF METHODS OF CHARGING FOR OVERDEPTH

Depth feet	Based on data in this study: Relative charge, percent	Based on data in this study: Dollar value per 100 ft*	Based on constant charge of 10 cents per lineal foot per foot of overdepth below 4 ft: Relative charge percent	Based on constant charge of 10 cents per lineal foot per foot of overdepth below 4 ft: *Dollar value per 100 ft
3.0	73	$10.22	100	$14.00
3.5	85	11.90	100	14.00
4.0	100	14.00	100	14.00
4.5	122	17.08	136	19.00
5.0	158	22.12	171	24.00
5.5	221	30.94	207	29.00

*Based on $14.00 per 100 ft for a depth of 4 ft.

Summary and Conclusions

These data on trenching-machine operation are based primarily on field observations and on questionnaires sent to contractors. In Iowa and southern Minnesota, 100 observations were obtained on four makes of wheel and endless-chain machines during a four-year period. Time loss studies were made in 1950 on one machine, and detailed records on the cost of operation of this machine were kept for a period of three years.

For depths from 3 to 5 ft the continuous rate of digging, Y, for average conditions can be expressed by the equation, $Y=768-114X$, where X is the depth in feet. Thus, increasing the depth 1 ft decreases the digging speed 114 fph. Increasing the depth from 3 to 5 ft decreased the digging speed 53.5 percent.

Under Iowa and southern Minnesota conditions there are about 185 available working days per year. These studies indicate that a trenching machine operates only 34.4 percent of this time; the remaining 65.6 percent is lost because of weather, repairs, making of junctions, moving and servicing the machine, and miscellaneous causes. Decreasing the amount of time lost by 30 min per day can decrease the cost per foot by about 10 percent.

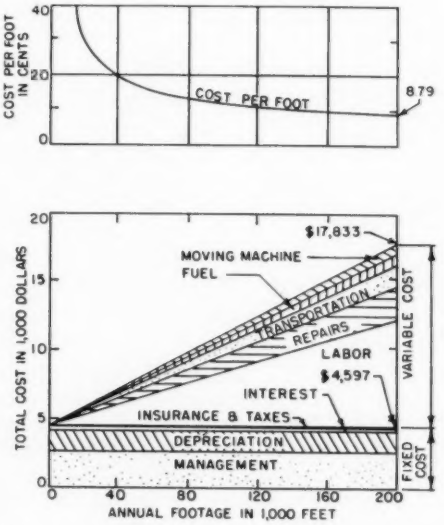

Fig. 5 Effect of annual use on the cost of operating tile-trenching machines. From DeVries(2)

The total average cost of operation for the one machine during a 3-year period was $16,311 per season, $100.40 per day, and 9.3 cents per foot. The average annual use of the machine was 164.5 days, an average of 1,070 ft were installed per day, and the total footage per season was 177,300 feet. For this footage the fixed costs averaged 28.2 percent of the total cost of operation, and the variable costs 71.8 percent. A questionnaire sent to contractors indicated an annual average use of 133 days and a total footage per season of 124,000 ft.

At a basic charge of $14 per 100 ft at a depth of 4 ft, a constant charge of 10 cents per lineal foot per foot of overdepth is within 11 percent of overdepth charge based on continuous digging rates given in Fig. 2. For the continuous digging rates the relative charge for overdepth for each 0.5 ft increase in depth below 4 ft is 22, 36, and 63 percent, respectively (column 2, Table 1), compared to a uniform increase of 35.7 percent for a constant charge of 10 cents per linear foot, shown in column 4 of Table 1.

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Estimating Hydraulic Roughness Coefficients

Woody L. Cowan

The selection or estimation of roughness coefficients is an important phase of hydraulic determinations associated with natural streams, floodways and similar channels. This paper describes a procedure for making estimates of roughness coefficients. The method of approach is systematic and rational in character.

THE suggested procedure for estimating the roughness coefficient n involves, first, the selection of a basic value for n for a straight, uniform, smooth channel in the natural materials involved, then, through critical consideration of five primary factors affecting n, the selection of a modifying value associated with each factor. The modifying values are added to the basic value to obtain n for the channel under consideration.

The procedures described in this paper were developed for the estimation of the roughness coefficient n in Manning's formula. This formula is now widely used, it is simple to apply, and it is regarded as reliable for hydraulic determinations in open channels.

In general, it is easier to estimate n for pipes and lined channels than for natural channels. In the case of pipes or lined channels a given situation will afford specific information on such factors as size and shape of cross section, alignment, type and condition of the material forming the wetted perimeter. Definite knowledge of these factors, associated with published results of experimental investigations and experience, makes possible selection of n values within reasonably well-defined limits of probable error. In the case of natural streams or channels excavated in natural materials, where the channel characteristics and conditions are more varied and complexly interrelated, the estimate of n is more difficult to make.

There seems to have developed a tendency to regard the selection of n for natural channels as either an arbitrary or an intuitive process. This probably results from the rather cursory treatment of the roughness coefficient in most widely used hydraulic textbooks and handbooks. The limited number of widely distributed reports on cases where n values have been derived from reliable discharge measurements may also contribute to the rather arbitrary methods of n selection that are often used.

The fact is that realistic estimates of n for natural channels require the exercise of critical judgment in the evaluation of the factors that influence n. In most projects the need for good n values justifies the adoption of a systematic estimation procedure.

Factors Affecting Value of *n*

The roughness coefficient is used to express quantitatively the degree of retardation of flow. The value of n indicates not only the roughness of the wetted perimeter but also the effect of all types of irregularity. Houk* and Ganguillet and Kutter† support this interpetation of the significance of n. It may, therefore, be stated that n is used to indicate the net effect of all factors causing retardation of flow in a reach of channel under consideration.

Some reports and technical papers have pointed out that the value of n depends on as many as 8 or 10 factors. This procedure was developed on the assumption that realistic estimates of n may be made through recognition of five primary factors: irregularity of the surfaces of the channel sides and bottom; variations in shape and size of cross sections; obstructions; vegetation; meandering of channel.

Procedure for Estimating *n*

The procedure involves, first, the selection of a basic value of n for a straight, uniform, smooth channel in the natural materials involved, then, through consideration of the five factors listed above, the selection of a modifying value associated with each factor. The modifying values are added to the basic value to obtain n.

In the selection of the modifying values it is important that each factor be given independent consideration. It should be remembered that n represents a quantitative expression of retardation of flow. Turbulence of flow can, in a sense, be visualized as a general measure or indicator of retardance. Therefore, in each case, more critical judgment may be exercised if it is recognized that, as the conditions associated with a given factor change so as to induce greater turbulence, there should be an increase in the modifying value. A discussion and tabulated guide to the selection of modifying values for each factor are given under the following procedural steps:

Step 1, selection of basic n value. This step requires the selection of a basic n value for a straight, uniform, smooth channel in the natural materials involved. The selection involves consideration of what may be regarded as a hypothetical channel. The conditions of straight alignment, uniform cross section, and smooth side and bottom surfaces should be kept in mind. Thus the basic n will be visualized as varying only with the materials forming the sides and bottom of the channel. The minimum values of n shown by reported test results for the best channels in earth are in the range from 0.016 to 0.018. Practical limitations associated with maintaining smooth and uniform channels in earth indicate that 0.02 is a realistic basic n. The basic n, as it is intended for use in this procedure, for natural or excavated channels, may be selected from the table that follows. Where the bottom and sides of a channel are of different materials, this fact may be recognized in selecting the basic n.

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*"Calculation of Flow in Open Channels" by Ivan E. Houk, Technical Reports Part IV, The Miami Conservancy District, Dayton, Ohio, 1918, pp. 136-143.

†"A General Formula for the Uniform Flow of Water in Rivers and Other Channels" by E. Ganguillet and W. R. Kutter, translated from the German with additions, by Herring and Troutwine, pp. 54-55 and 98-99.

Character of Channel	Basic n
Channels in earth	0.02
Channels cut into rock	0.025
Channels in fine gravel	0.024
Channels in coarse gravel	0.028

Step 2, Selection of modifying value for surface irregularity. The selection is based on the degree of roughness or irregularity of the surfaces of channel sides and bottom. Surface irregularity is considered, first, in relation to the degree of surface smoothness attainable in the natural materials involved and, second, in relation to the depths of flow under consideration. Actual surface irregularity comparable to the best surface to be expected of the natural materials involved calls for a modifying value of zero. Higher degrees of irregularity induce turbulence and call for increased modifying values. The table that follows may be used as a guide to the selection.

Degree of irregularity	Surfaces comparable to	Modifying value
Smooth	The best attainable for the materials involved	000
Minor	Good dredged channels, slightly eroded or scoured side slopes of canals or drainage channels	0.005
Moderate	Fair to poor dredged channels, moderately sloughed or eroded side slopes of canals or drainage channels	0.010
Severe	Badly sloughed banks of natural streams; badly eroded or sloughed sides of canals or drainage channels; unshaped, jagged and irregular surfaces of channels excavated in rock	0.020

Step 3, Selection of modifying value for variations in shape and size of cross section. In considering changes in size of cross sections, judge the approximate magnitude of change in relation to the average section. Changes of considerable magnitude, if they are gradual and uniform, do not cause significant turbulence. The greater turbulence is associated with alternating large and small sections where the changes are abrupt. The degree of effect of size changes may be best visualized by considering it to depend primarily on the frequency with which large and small sections alternate and secondarily on the magnitude of the changes.

In the case of shape variations, consider the degree to which the changes cause the greatest depth of flow to move from side to side of the channel. Shape changes causing the greatest turbulence are those for which shifts of the main flow from side to side occur in distances short enough to produce eddies and upstream currents in the shallower portions of those sections where the maximum depth of flow is near either side. Selection of modifying values may be based on the following guide:

Character of variations of size and shape of cross sections	Modifying value
Change in size or shape occurring gradually	0.000
Large and small sections alternating occasionally or shape changes causing occasional shifting of main flow from side to side	0.005
Large and small sections alternating frequently or shape changes causing frequent shifting of main flow from side to side	0.010 to 0.015

Step 4, Selection of modifying value for obstructions. The selection is based on the presence and characteristics of obstructions such as debris deposits, stumps, exposed roots, boulders, fallen and lodged logs. Care should be taken that conditions considered in other steps are not re-evaluated or double-counted by this step. In judging the relative effect of obstructions, consider *(a)* the degree to which the obstructions occupy or reduce the average cross sectional area, *(b)* the character of obstructions (sharp-edged or angular objects induce greater turbulence than curved, smooth-surfaced objects), and *(c)* the position and spacing of obstructions transversely and longitudinally in the reach under consideration. The following table may be used as a guide to the selection:

Relative effect of obstructions	Modifying value
Negligible	0.000
Minor	0.010 to 0.015
Appreciable	0.020 to 0.030
Severe	0.040 to 0.060

Step 5, Selection of modifying value for vegetation. The retarding effect of vegetation is probably due primarily to the turbulence induced as the water flows around and between the limbs, stems and foliage, and secondarily, to reduction in cross section. As depth and velocity of flow increase, the force of the flowing water tends to bend the vegetation. Therefore, the ability of vegetation to cause turbulence is partly related to its resistance to bending. Furthermore, the amount and character of foliage, that is, growing-season condition versus dormant-season condition, are important. In judging the retarding effect of vegetation, critical consideration should be given to the following: height in relation to depth of flow; capacity to resist bending; the degree to which the cross section is occupied or blocked out; the transverse and longitudinal distribution of vegetation of different types, densities and heights in the reach under consideration. The following table may be used as a guide to selection of the modifying value:

Vegetation and flow conditions comparable to:	Degree of effect on n	Range in modifying value
Dense growths of flexible turf grasses or weeds, of which Bermuda grass and bluegrass are examples, where the average depth of flow is two or more times the height of the vegetation.		
Supple seedling tree switches such as willow, cottonwood or salt cedar where the average depth of flow is three or more times the height of the vegetation.	Low	0.005 to 0.010
Turf grasses where the average depth of flow is one to two times the height of the vegetation.		
Stemmy grasses, weeds or tree seedlings with moderate cover where the average depth of flow is two to three times the height of the vegetation.		
Brushy growths, moderately dense, similar to willows one to two years old, dormant season, along side slopes with no significant vegetation along bottom, where the hydraulic radius is greater than two.	Medium	0.010 to 0.025
Turf grasses where the average depth of flow is about equal to the height of vegetation.		
Willow or cottonwood trees 8 to 10 years old intergrown with some weeds and brush, dormant season, where the hydraulic radius is 2 to 4 ft.		
Bushy willows about one year old interwoven with some weeds in full foliage along side slopes, no significant vegetation along channel bottom where hydraulic radius is 2 to 4 ft.	High	0.025 to 0.050

Turf grasses where the average depth of flow is less than one-half the height of the vegetation.		
Bushy willows about one year old intergrown with weeds along side slopes, dense growth of cattails along channel bottom, all vegetation in full foliage, any value of hydraulic radius up to 10 or 12 ft.		
Trees intergrown with weeds and brush, all vegetation in full foliage, any value of hydraulic radius up to 10 or 12 ft.	Very high	0.050 to 0.0100

Step 6, Determination of the modifying value for meandering of channel. The modifying value for meandering may be estimated as follows: Add the basic n for step 1 and the modifying values for steps 2 through 5 to obtain the subtotal n_s. Determine the ratio of the meander length of the channel to the straight length of the reach. Compute the modifying value for meandering in accordance with the following table:

Ratio of meander length to straight length	Degree of meander	Modifying value
1.0 to 1.2	Minor	0.000
1.2 to 1.5	Appreciable	0.15 n_s
1.5 and greater	Severe	0.30 n_s

Where lengths for determining the approximate value of the ratio of meander length to straight length are not readily obtainable, the degree of meander can usually be judged with sufficient accuracy.

Step 7, Computation of n for the reach. The value of n for the reach is the sum of the values determined in steps 1 through 6.

A sample computation of n for a channel reach is presented below. This illustration is based on a case reported in U. S. Department of Agriculture Technical Bulletin No. 129‡ which is designated South Forked Deer River at Campbell's Levee Road near Jackson, Tenn., Old Crooked River Channel. The following description of the test reach is quoted from Table 3, page 32 of the Bulletin: "Course, very crooked, containing four distinct curves; 705 ft long at low water. Cross section, large variations in shape; for variation in size, see fig. 6, M. Side slopes, very irregular. Bottom, very irregular and full of holes. Soil, sandy clay loam. Condition, many roots, trees, and bushes on sides, and many logs, large trees and other drift on bottom; trees are continually falling into channel, due to caving banks. (Pl. 10, B and fig. 5, M.)"

Estimation of n:

Step	Remarks	Modifying values
1	Basic n, channel in earth	0.020
2	Description indicates severe irregularity	0.020
3	Description indicates changes in size and shape have high effect	0.010
4	Description indicates obstructions have severe effect	0.040
5	Description indicates vegetation has medium effect	0.025
6	Subtotal n_s=0.115 Description indicates severe meander (0.30 × 0.115)	0.034
7	Estimated n for the reach	0.149

NOTE: USDA Technical Bulletin No. 129 reports test values of n for this channel ranging from 0.140 to 0.162.

Cases Involving Both Channel and Overbank Flow

Work with natural streams and floodways often requires consideration of a wide range of discharges. At the higher stages both channel and overbank or floodplain flow are involved. Normally the conditions are such that the channel and floodplain have different degrees of retardance and, therefore, different n values. In such cases the quality of the hydraulic determinations will be improved by dividing the cross sections into parts or subdivisions.

In the majority of natural streams and similar channels, n tends to decrease as stage increases up to, or somewhat above, the bankfull stage, then to increase with further increases in stage. This statement is based on a study of an appreciable number of reported cases where n has been determined for a relatively wide range in stage. It should not be taken to imply that n increases indefinitely with increases in overbank stage. The reason for, and the effect of, subdividing the cross section is to permit n for the entire cross section to vary with stage above the bankfull stage.

The usual practice is to divide the cross section into two parts, one subdivision being the channel and the other the floodplain. More than two subdivisions may be made if conditions indicate wide variations of n. However, in view of the practical aspects of the problem, more than three or four subdivisions would not normally be justified.

In estimating n for the channel subdivision all of the factors and procedural steps discussed above would be considered. Although conditions may indicate some variation of n with stage in the channel, it is recommended that an average n be estimated for use in the hydraulic computations for all within channel stages.

In the case of floodplain subdivisions the estimate would consider all factors except meandering. That is, the estimate would employ all of the procedural steps except Step 6. Floodplain n values will normally be somewhat greater than the channel values. Floodplain conditions usually do not indicate an n less than 0.05 to 0.06. Many cases will justify values in the 0.07 to 0.09 range and cases calling for values as high as 0.15 to 0.20 may be encountered. These higher values apply primarily because of the relatively shallow depths of flow. The two factors requiring most careful consideration are obstructions and vegetation. Most agricultural floodplains have fairly dense networks of fences to be evaluated as obstructions in Step 4. Vegetation probably should be judged on the basis of growing season conditions.

Limitations on Use of the Procedure

The procedure described in this paper may merit consideration in the investigation and design of many projects dealing with the hydraulics of natural streams, floodways and similar channels. However, the following limitations should be recognized in reaching a decision as to its use.

First, in the development of the procedure no attempt was made to consider channels having highly unstable sand beds where appreciable scour and high sediment transport are associated with the higher discharges. In such cases the method of approach should attempt to recognize the varying degrees of admixing of sediment and water.

Second, the modifying values listed under the various factors have been developed from a study of some 40 to 50 reported cases where n has been determined for channels ranging from small to moderate size. These values should be regarded as questionable for large channels. It is, therefore, recommended that the modifying values be used with caution in dealing with channels where the hydraulic radii exceed 15 ft.

‡"Flow of Water In Drainage Channels," by C. E. Ramser, USDA Technical Bulletin, No. 129, U. S. Government Printing Office, Washington, D. C., Nov., 1929.

Breather Bag for CA Fruit-Vegetable Storages

I. J. Pflug
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The author discusses selection and operation of a breather bag for the controlled-atmosphere type of fruit and vegetable storage, and shows how it acts to reduce air leakage and as a safety device

IN the CA (controlled-atmosphere) type fruit and vegetable storage described by Smock (4)* the temperature is regulated and the level of oxygen and carbon dioxide is controlled. The equilibrium oxygen level must be equal to or below the desired control point if the oxygen level is to be controlled. The equilibrium oxygen level is determined by the rate at which the fruit consumes oxygen and the rate at which oxygen leaks into the storage room with the outside air. The rate of utilization or respiration is more or less fixed by the fruit variety and the storage temperature; therefore, the suitability of a room for CA storage is determined by leakage rate. Since leakage is a function of pressure differentials arising from several sources, (Pflug and Dewey, 2) any mechanism that reduces pressure differentials will have a substantial effect on the equilibrium oxygen level.

The possible use of an expansion device or breather bag to reduce leakage in CA storages was proposed by Pflug and Southwick (3). They found that pressure differentials and accompanying leakage due to temperature cycling of the refrigerator could be reduced through the use of a suitable breathing device. Continued study of the leakage characteristics of refrigerated CA storages indicates that the volume change is proportional to absolute temperature changes and that the temperature cycle is of the general shape illustrated in Fig. 1. The frequency of the temperature cycle is a function of the temperature differential of the off-on thermostat and the heat gain on the refrigerator; however, total leakage is related to the heat gain of the storage rather than the differential of the thermostat.

The breather bag serves as a reservoir for the confined storage room and functions by giving up air to the room during the cooling part of the temperature cycle. It operates in parallel with the leaks in the storage room; therefore, to be effective it must supply and recover air with very small pressure differentials. As the bag is made more efficient, the amount of air entering the room through the leaks will be reduced; however, some air will always enter and leave the storage room through the leaks.

In making recommendations for a breather bag, the space requirement and cost must be balanced with desired efficiency. The breather bag should be large enough to supply the room with the required air with a differential pressure of 0.005 in of water. The shape of the breather bag is very important, since it must supply and then recover air from the storage. The breather bag is located outside of the storage room and in order to function must contain a large volume of air at equilibrium (The pressure inside the bag is equal to atmospheric pressure). To accomplish this the bag is supported by a rectangular frame (Fig. 2) that permits the lower portion of the bag to assume the shape of a catenary (at equilibrium). The pressure-volume characteristics of a bag that contains air at equilibrium are related

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*Numbers in parentheses refer to the appended references.

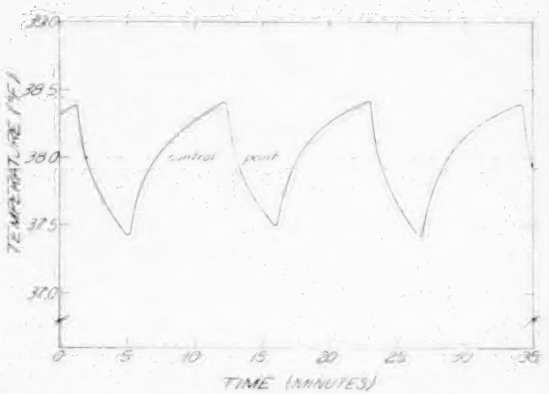

Fig. 1 Actual temperature cycle of refrigerated apple storage using on-off temperature control

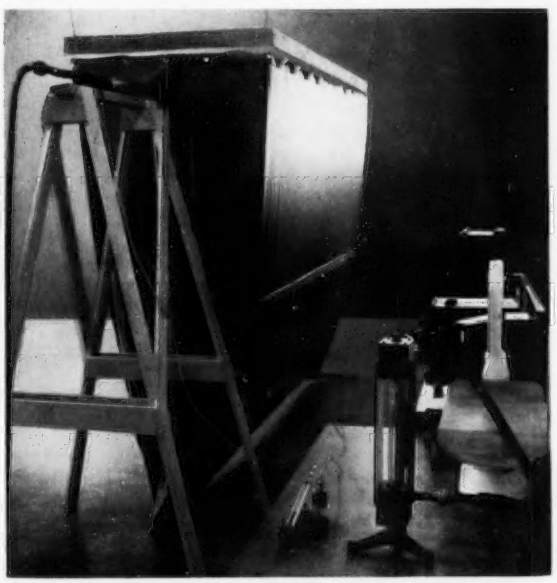

Fig. 2 Breather bag undergoing tests to determine pressure-volume characteristics

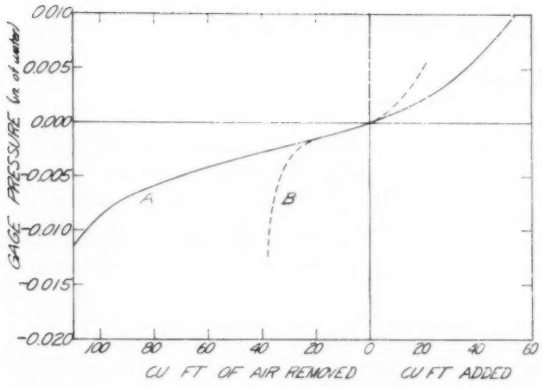

Fig. 3 Pressure-volume characteristics of two sizes of breather bags

to the length and width of the supported top, the depth, and the weight of the material from which the bag is fabricated. Increasing either the length, width, or depth increases the quantity of air that can be removed from the bag for a given pressure differential. Increasing the weight of material from which the bag is fabricated reduces this quantity.

Two sizes of breather bags have been designed specifically for CA rooms and have been tested to determine their pressure-volume characteristics. One of these breather bags is illustrated in Fig. 2. The large bag has a 3×10-ft top and a depth of 7 ft at equilibrium; the smaller bag has a 3×5 ft top and a 7-ft depth. Both bags were fabricated from 12 mil (0.012 in) vinyl sheeting. The pressure-volume characteristics of these bags are illustrated in Fig. 3.

The size of breather bag required for a given CA storage will depend on the air exchanged per temperature cycle. This is a function of the size of the room, the temperature differential of the thermostat and the refrigeration capacity in relation to the storage size. In making a design for general application the following average conditions will be used: thermostat differential, 2 F; cubic feet of atmosphere per cubic foot of storage volume, 0.65. The resulting volume change per 1000 cu ft of storage is 2.6 cu ft per 2 F temperature change. Referring to Fig. 3 it is found that the large bag (Curve A) will give up about 60 cu ft under the design conditions and is sufficient to take care of a 23,000-cu ft room and the small bag (Curve B) is adequate for a 9200-cu ft storage.

A breather bag will not be of value in reducing room leakage if the connecting tubing and fittings require large pressure differentials to move the air from the bag to the room. The effect of an undersized connecting tube was pointed out by Pflug and Southwick (3). It is recommended that a 3-in I.D. duct be used to connect the breather bag to the storage room. This duct should be as short as possible with minimum number of bends or elbows. If the conditions of the installation call for a long duct or several elbows, the duct should be sized for the particular installation using a design pressure drop of 0.005 in of water and duct friction data contained in the ASHVE Guide (1).

The breather bag should be connected to the room at a point where it will not be subjected to negative or positive pressures created by the evaporator fans. Some type of rigid perforated duct should be used in the bag to prevent the collapsing bag from sealing the outlet when the CA storage room rapidly withdraws air from the bag.

Summary

The selection of the proper size of breather bag and connecting duct for a CA fruit or vegetable storage has been outlined and the operation of the bag explained. The breather bag acts to reduce air leakage due to temperature cycling and at the same time acts as a safety device for the room. In general, a properly sized and installed breather bag may reduce the leakage from temperature cycles by 50 percent; however, the breather bag will not reduce leakage from pressure differentials induced by evaporator fans, wind or changing barometric pressures.

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3 Pflug, I. J. and Southwick, F. W. Air leakage in controlled-atmosphere storage. AGRICULTURAL ENGINEERING, 35, pp. 635-637. September, 1954.

4 Smock, R. M. Controlled-atmosphere storage of apples. Cornell University. Ext. Bul. 759, 39 pp. 1949.

High School Engineering Program

JUNIOR Engineering Training for Schools (JETS), a science-club plan originated in 1950 by Lorin G. Miller, former dean of engineering at Michigan State University, now includes 75 clubs in eighteen states, with an active membership of more than 2,000 high school boys and girls. The JETS program is intended to do for engineering what 4-H and FFA have long been doing for agriculture.

The JETS clubs get first-hand information from a variety of sources. Projects are recommended, conferences and talks are sceduled by college staff members or industrial engineers, films and publications are obtained for study and review. To help clubs get started, JETS headquarters has supplied lists of suitable projects, and an index of more than 100 motion pictures available without charge from industry and other organizations. Added incentives for members of JETS are provided by judging recognition of club projects and by scholarship awards to the outstanding member in each club.

Success of the JETS program has already brought requests for information from more than 60 engineering colleges, societies, and industries. The JETS idea has been developed as a national second-school pattern which can be utilized freely by engineering colleges everywhere. Additional information may be obtained from Director Harold P. Skamser, School of Engineering, Michigan State University, East Lansing. (*Journal of Engineering Education*, March, 1956)

Cultivator Mounting Standard

The ASAE Standard on Cultivator Sweep and Shovel Mountings, adopted in March 1955 and published in the 1955 edition of the Agricultural Engineers Yearbook, was inadvertently omitted from the 1956 edition. Copies of the standard are available from the Central Office of ASAE.

V-Belt Drive Design Improved

Albert J. Garbin

The author discusses how improved agricultural V-belt drive design in recent years has been made possible as a direct result of the adoption and application of the ASAE-sponsored standard for V-belt drives, and how even larger benefits may be derived from it.

SIX years ago the American Society of Agricultural Engineers in collaboration with the Rubber Manufacturers Association and the Farm Equipment Institute adopted a V-belt-drive standard (ASAE Standard: V-Belt Drives for Farm Machines"). Sufficient time has now elapsed so that we may look back and determine what this standard has accomplished for the agricultural equipment industry.

By conforming to this ASAE standard the problem of insufficient belt take-up has been eliminated. The designer now has a definite guide in the standard for the amount of adjustment required for a drive. By incorporating the recommendations in the final design, this trouble source has been eliminated.

The use of deep-groove sheaves on quarter-turn drives, as recommended in the standard, has kept the V belt from jumping the sheaves. This has minimized the time lost in the field by the farmer in reassembling the belt drive.

Improved belt delivery and economy has resulted in the use of the lengths recommended in the standard. All of the major V-belt manufacturers have mold equipment to produce these standard lengths, and time-consuming and costly equipment purchases are not needed when these lengths are specified by the designer.

Because of the standardized measuring procedure, belt-length interpretation differences between the consumer and supplier have virtually ceased. Now everyone who is using the standard is measuring with the same size sheaves and same measuring tensions. This eliminates the need for correction factors which were previously employed and which were a source of error on occasions.

The purpose of the ASAE standard is to guide the agricultural equipment engineer in designing an economical and trouble-free V-belt drive. From the foregoing it can be seen that this has been accomplished in many instances. The acceptance of the standard by the industry has been most gratifying, but unfortunately there have been a few instances where the designer has deviated from the standard. In most such cases this has lead to troublesome drives where frequent belt replacement has been necessary.

One particular source of trouble has been on back-bend idler designs where the designer specifies idlers below the minimum shown in the standard. In addition to a stress pattern through zero on this type of drive, the base of the belt is exposed to abnormally high tensile stresses causing cracking and rapid failure. By keeping to the recommendations the stress range is kept within reasonable limits and nominal belt life is obtained.

Another point where designers tend to stray from the accepted standard is on twisted belt drives, when the tangent length or center distance on such drives is below recognized minimums, and excessive wiping action of the belt entering and leaving the sheave takes place. This causes rapid belt sidewall wear and results in early failure. By keeping within the prescribed tangent lengths or center distances the belt is able to right itself thereby entering and leaving the sheaves properly with no undue sidewall wear.

The equipment designer is himself responsible for the last of the major trouble sources. To obtain an increase in speed variation, there has been a tendency to reduce the sheave angle from the recommended 26-deg included angle. This has caused considerable difficulty on spring-loaded adjustable-speed sheaves where the sheave angle has been lowered to increase speed variation for a given belt width. This reduction requires an increase in spring pressure causing a crushing effect on the belt and its consequential early failure. This problem was recognized and considered at the time the various details of the standard were developed, and the 26-deg angle was based on years of experience both in the laboratory and in the field by the V-belt and agricultural equipment manufacturers. By following the standard, the horizontal component of the sidewall force is low enough to enable the belt to withstand the effect and give a satisfactory service life.

One item that is not defined in the standard is the minimum sheave diameters. It has been the practice of our company to recommend the following diameters:

Belt Section	Belt nominal top width, in	Recommended minimum sheave O.D., in	Absolute minimum sheave O. D., in
HA	1/2	2.75	2.0
HB	21/32	4.00	3.0
HC	7/8	5.75	5.0
HD	1 1/4	9.00	8.0
HE	1 1/2	13.00	11.0
For double V belts the minimum O.D. is as follows:			
HAA		3.00	2.5
HBB		4.75	4.0
HCC		6.75	6.0
HDD		11.50	10.0
HEE		17.50	15.0

NOTE: On extremely high shock loading or on very slow-speed drives, the sheave diameter should not be smaller than the recommended minimum.

The wide approval of the ASAE standard has stimulated additional work on new and improved data which it is believed will be incorporated in the standard at some time in the future. At present, because of its many advantages, greater acceptance of the ASAE standard for V-belt drives is advocated for farm machines.

Paper prepared expressly for AGRICULTURAL ENGINEERING.

The author — ALBERT J. GARBIN — is senior product engineer, field engineering and development department, the B. F. Goodrich Industrial Products Co.

Split Wood Joints

V. L. Hauser and L. W. Neubauer
Assoc. Member ASAE Member ASAE

Compression tests reveal that nailed wooden joints are strong enough to exceed design load with accepted safety factor, despite moderate splitting.

DESIGN of wood joints is often limited by the number of nails which can be used safely without splitting the wood of the joint. Some surprising and interesting results developed in a test of nailed joints which had suffered several cracks during assembly. The arrangement required many nails crowded into a 6 x 6-in lapped joint.

Design

The design load was 2000 lb compression, parallel with the grain of the wood. The member used was 2 x 6-in fir with 1 x 6-in pine splice plates. The splice was designed for an allowable load of 53 lb per nail for 8d nails and 71.5 lb per nail for 10d nails. A joint having 6d nails was also constructed, but the number of nails used had to be reduced below the number required for conventional design due to excessive splitting of the wood. The splice plates overlapped the main member 5⅜ in, making a contact area between splice plate and member of 31.7 sq in, on each side. Total length of the test assembly was 12 in. One-half of the total number of nails was driven into each side of the splice. Fig. 1 shows the details of the spliced joint used.

Splitting

The main 2 x 6-in fir member, in each of the four test joints, split while the joint was being nailed together. Most of the splitting occurred when the second plate was nailed on. This is attributed to the possible alignment, relative to the grain, of nails driven from opposite sides of the splice. The pine 1 x 6-in splice plates did not split during the construction of the joint.

Fig. 2 *(upper left)* shows a view of the typical splitting of the main member before testing. The 10d nails, Fig. 2, *(upper right)* caused the greatest splitting before testing.

Test

The joints were tested in a universal testing machine, in compression. Horizontal lines were drawn on each joint prior to testing, Fig. 2 *(lower right)*. The load at which the first slippage between members occurred was recorded. Each joint was compressed until further increase in strain did not produce an increase in the load carried. This load was recorded as the maximum load.

One joint with 8d nails was tested to destruction to determine the method of failure of the joint, Fig. 2 *(lower left)*.

Results of the test are given in Table 1 (on page 481).

Type of Failure

All joints failed by withdrawal of nails from the center member, bending of the nails, and splitting of the wood, Fig. 2 *(upper right)*.

(Continued on page 481)

Paper prepared expressly for AGRICULTURAL ENGINEERING.

The authors — V. L. HAUSER and L. W. NEUBAUER — are, respectively, graduate student and associate professor of agricultural engineering, University of California, Davis.

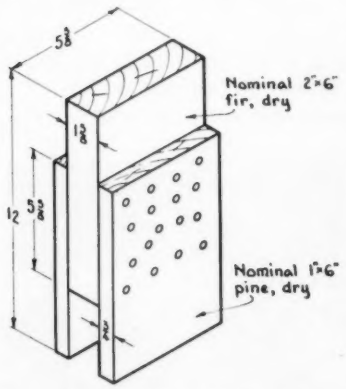


Fig. 1 *(Above)* Nailed wooden joint constructed of 2 x 6-in fir member and 1 x 6-in pine splice plates.

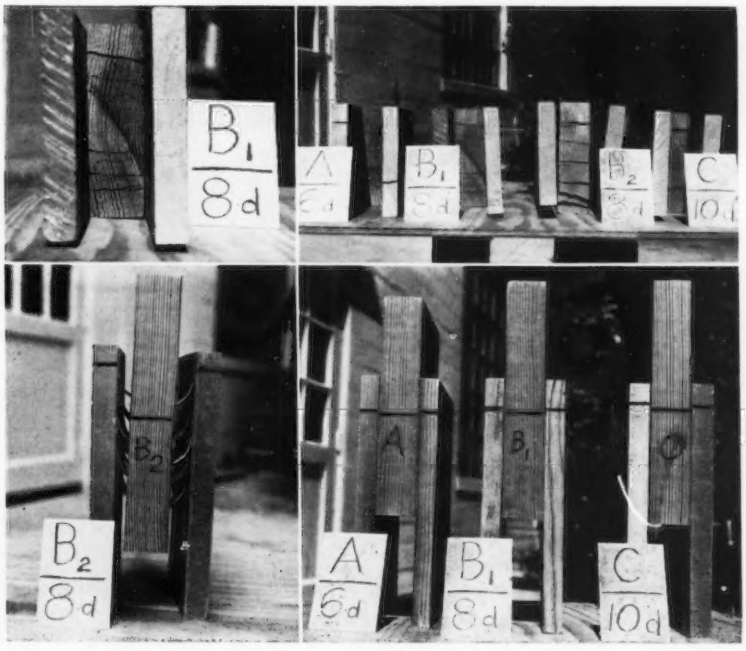


Fig. 2 *(Right)* Views of split nailed wooden joints. *(Upper left)* Typical splitting of main member before compression testing. *(Upper right)* Comparison of splitting after testing. *(Lower left)* Joint tested to destruction. *(Lower right)* Deflection or slippage at maximum load.

Instrument for Measuring Soil Condition

J. H. McClelland

Some of the inherent spatial variations of soil resistance were sufficiently great to invalidate any conclusions based on the assumption of uniform soil.—*Keen**

The instrument described in this paper is a soil probe or continuously recording horizontal penetrometer devised for evaluating mechanical properties of the soil familiar to the engineer, including shear strength, cohesion, adhesion, particle and pore size and distribution and resistance to vertical penetration

THE assumption of uniform soil is often a necessity in tests of agricultural implements. But, where this assumption is made for convenience, it may be difficult to assess the worth of the results. Admittedly for any one test proper statistical design and analysis can distinguish and assess differences arising from variations in soil properties. Usually, however, a series of tests is needed and it may not be proper to compare tests on, say, the same implement on the same soil at different times. In any event an assessment of the soil properties should be a vital part of the experimental data†.

The problem is what soil properties to evaluate and how. The usual method is to try to obtain representative values for those mechanical properties familiar to the engineer: shear strength, cohesion, adhesion, particle and pore size, and distribution and resistance to vertical penetration, for example. These measurements may, with some justification, be used to form a basis of comparison of soils; they may be used to assess the importance of the factors involved. But there are objections; there is little knowledge of the relationship between the properties of a soil treated in the laboratory before testing and its properties in situ. Some tests (*e.g.*, shear strength) can be done in situ — as can penetrometer tests—but this gives rise to a further objection. Variations of properties over the area used for an implement test may be of a large order; for reasonable precision,

Paper prepared expressly for AGRICULTURAL ENGINEERING.

The author—J. H. MCCLELLAND—is officer of the plant fiber section, Commonwealth Scientific and Industrial Research Organization, formerly of the School of Agriculture, University of Melbourne (Australia). (The equipment described in this paper was partly developed during the author's association with the University.)

*Keen, B. A. The physical properties of the soil. p. 236, 1931. Longmans Green and Co.

†Nichols, M. L. and Reaves, C. A. Soil structure and consistency in tillage implement design. AGRICULTURAL ENGINEERING, 36:517 (1955).

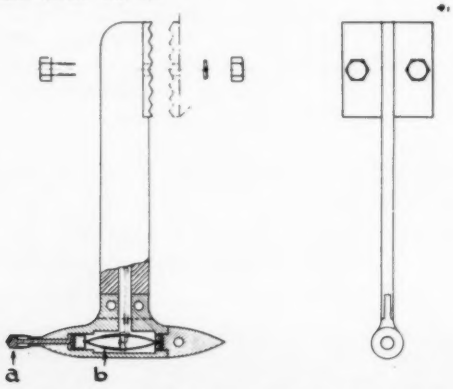


Fig. 1 General assembly of the soil probe showing *(a)* pressure tip and *(b)* load cell, with wiring to strain gages shown diagrammatically

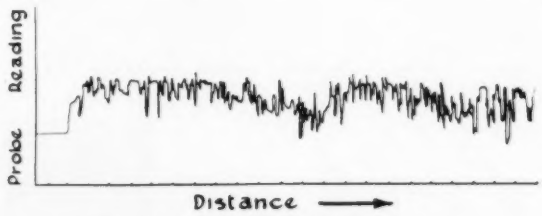


Fig. 2 A trace obtained from the soil probe

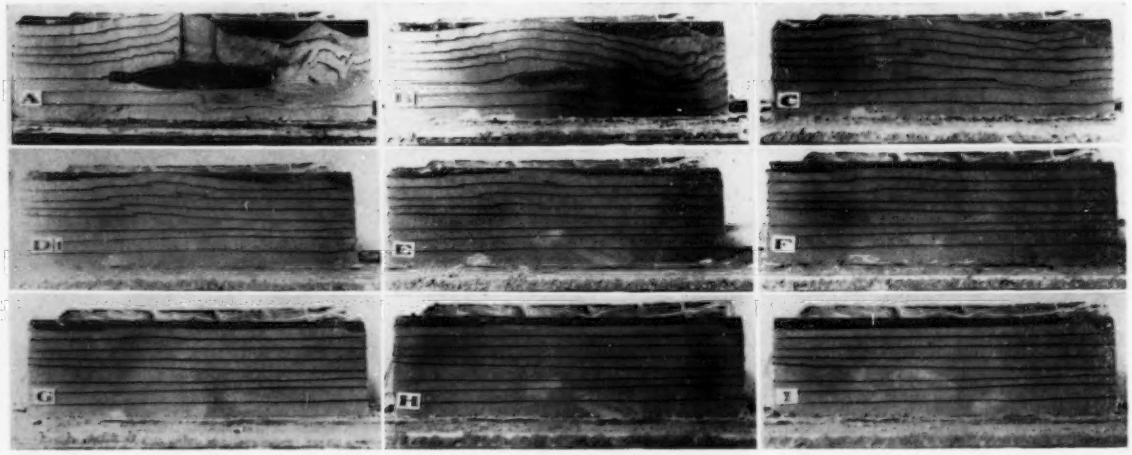


Fig. 3 A series of photographs taken at ½-in intervals from the center line of the probe to the outside edge of the disturbed zone and sand box. The successive failures caused by the tip and spoonlike shape of the failure surface can be seen

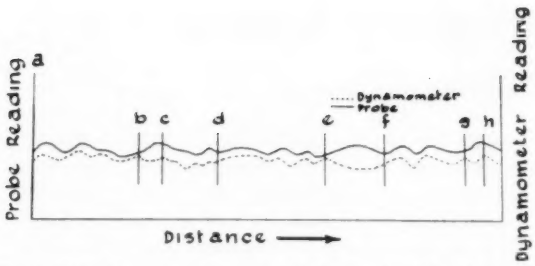


Fig. 4 This shows a probe trace and the graph of drawbar pull. Both recorders were damped. The curves indicate a change of correlation. (Different parts of the curves and their possible meaning are discussed in the accompanying text)

samples must be taken over a fairly close grid. This takes time and, if the weather changes, the soil may well be in a different condition at the time of the actual test. So, it seems desirable to assess the over-all condition of the soil at the time of the test.

For this reason the instrument described in this paper was designed to measure the condition of a soil. In particular, interest lay in a possible relationship between the draft of the implement (always considering the contribution from rolling resistance and hitch geometry) and the physical condition and mechanical properties of the soil under review. It was decided that measurements should be continuous and recorded; the instrument should be adjustable for depth and be carried (just ahead of the tool) by the implement frame.

The instrument is shown in Fig. 1; here the transmission is electric but a mechanical or hydraulic system may be used. However, the strain-gage load cell with bridge and cathode-ray oscilloscope and camera or a pen recorder has the advantage of large amplification (if needed) with no lost motion.

In operation, as the probe enters the soil the load cell deforms as the tip applies a load on the soil immediately ahead. Deformation continues until there is sufficient force to cause failure (by shear to the free surface) in the soil. Immediately failure occurs, the probe tip is moving through a ruptured zone and the load cell members tend to return to their equilibrium position. As the probe continues to move forward, soil resistance builds up; the load cell starts to deform and the cycle is repeated. This sequence can be seen from the probe trace reproduced in Fig. 2.

For satisfactory operation, soil failure must be caused by the probe tip; in other words, the tip must be far enough ahead of the shank to ensure that the soil in which it is operating has not already been affected by some other part of the instrument. Attention was paid to this part in the original design, but, at the best, the design was based on rule of thumb, no precise data being available. Because of the importance of this point, laboratory tests were carried out to check if the design was satisfactory.

Alternate layers of dry colored sand were placed in a wooden box; the probe was moved through the sand until two or three successive failures showed on the surface. The sand was then set with gelatine. When the sand and gelatine were solid, the box was dismantled and successive cuts were made at ½-in intervals, each new surface exposed being vertical and parallel to the main axis of the probe. Fig. 3 (A-H) shows the position of the shear planes and the point of failure can be clearly seen in the photograph of the middle section (3A).

Having established that failure would occur preferentially at the probe point, field tests were undertaken. Fig. 4 shows curves obtained from the probe and a hydraulic drawbar dynameter (both heavily damped) on a test run using a three-furrow moldboard plow mounted on steel wheels. Though no claims are made for the importance of the curves, it does seem likely that a correlation could be obtained. In the main, the probe seemed to be reacting to the soil in much the same way as the plow. But the presence of inversion (B to C, E to F and G to H in Fig. 4) is a matter of interest. They occur at high probe readings. It may be that at these times the rolling resistance was lowered sufficiently to reduce the total energy demand of the plow. However, more work should make evidence available to support or deny this explanation.

It has not been possible to do any further work with the probe; its possibilities and its weakness are unknown, but experience does indicate that it is an instrument worth further testing.

Split Wood Joints

(Continued from page 479)

The nail heads did not pull through the splice plates in any joint, although some heads were drawn partly into the wood.

There was some splitting of the splice plates for all joints tested. Most of this splitting occurred where two nails were driven into or near the same grain.

Summary

1 Joints loaded in compression developed considerable strength even though the wood was split by nailing.

2 Ten pennyweight nails gave greater strength to the joint in spite of greater splitting of the wood.

3 All joints tested exceeded the design load before slipping began, with a safety factor of two or more.

4 Ten pennyweight nails had the highest safety factor.

5 This test gave no information on strength of split wooden joints after weathering.

Conclusions

Moderate splitting of the center member of a splice with splice plates on two sides is not serious. The use of large-size nails will increase the safety factor, when splitting is not severe.

TABLE 1. JOINTS TESTED IN UNIVERSAL TESTING MACHINE, IN COMPRESSION

Specimen	Nail size	Number of nails	Load at first slip (lb.)	Maximum load on joint (lb.)	Load,[1] pounds per nail			Safety factor	
					1st slip	Maximum	Design	Yield	Ultimate
A	6d	40	4000	7,140	100	178	50	2	3.6
B_1	8d	38	4000	10,380	105	273	53	2	5.2
B_2	8d	38	4000	9,920	105	261	53	2	5.0
B(ave.)	8d	38	4000	10,150	105	267	53	2	5.1
C	10d	28	7000	14,000	250	500	71.5	3.5	7.0

An Approach to Efficiency Studies

Frederick C. Winter

Objectives in efficiency studies may include, among others, cost reduction, conserving labor, reducing production time, improving service, and conserving product. In this paper the author presents an instructive approach to undertaking such studies.

IN MAKING a study of the relative efficiency of several processes, operations, or systems it is necessary to establish the objectives to be attained. An objective might be a reduction in total cost, the conservation of labor, performing the work in the shortest period of time, rendering a better service, conserving quality of product, or others. There are efficiencies to be attained in each of these areas and the efficiencies attainable in any one area may be at the expense of any one or all of those in the other areas. It is also possible to improve the efficiency in one or more areas at the same time. A change in one will have an influence on the others. It is for this reason that the primary and necessary secondary objectives must be formulated before the study is undertaken.

The most profitable areas for study in a system are those that use the most labor, operations that are costly, processes that are expensive, where preservation of quality is an important factor, where there is excessive in-process storage, where there is excessive materials handling, and where there is an unsatisfactory flow of material through the process. The complete system needs investigation in order to isolate the areas most subject to improvement. Once the trouble spots have been identified, each one should be investigated separately and solutions developed. However, care must be exercised in improving one stage of an integrated system to assure that it benefits those operations that come before it, as well as those that follow, if it is to make a contribution to the system as a whole. A careful investigation will often disclose temporary procedures that were set up to meet temporary conditions but which have become permanent. This type of opportunity should not be overlooked.

The initial approach to any study should be to increase efficiency without the addition of new equipment. This may be brought about by reorganizing handling methods, work crews, work methods and plant-facility layout. It is surprising the results that can be achieved without new capital expenditures.

The next step should be the substitution of new available equipment coupled with the proper work methods, layout and materials handling. The selected equipment should yield the least cost combination for equipment and labor for the scale of operation under consideration. The final step would be the development of totally new equipment and techniques. This latter stage is usually the most difficult and costly from a research point of view.

In order to bring about improved efficiencies it is necessary to find out how the operations are actually performed. It is said that there are three ways in which an operation may be performed: *(a)* the way it is actually performed, *(b)* the way people think it is performed, and *(c)* the way it is supposed to be performed. The first step, then, is to learn what is actually done in the system under study, which almost always means that the facts must be obtained by direct observation. When these facts have been learned, steps may be taken to devise the way the operations are supposed to be, or should be, performed to achieve greater efficiency.

The engineer, in studying an operation which he seeks to improve, requires a systematic way of investigating and of making observations as an aid in making his analysis. Among the available tools or techniques are flow process charts and flow diagrams.

Flow Process Chart and Flow Diagram

A flow process chart is a graphic representation of the sequence of all operations, transportations, inspections, delays and storages occurring during a process or procedure and might include, at each activity, information considered desirable for analysis such as time required and distance moved. It aids in visualizing what takes place and portrays the activities in the exact sequence in which they occur (Fig. 1). When, for certain types of analysis, only operations and inspections are used, the chart is known as a "process chart."

A flow diagram is a visual presentation which shows to scale on the plan view of the facility or area under study, where the various operations, inspections, and storages occur, and by the use of lines and arrows indicates the flow of work (Figs. 2 and 3).

Fig. 1 Flow process chart for an egg assembly plant

Paper presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1955, on a program arranged jointly by Farm Structures and Rural Electric Divisions.

The author — FREDERICK C. WINTER — is associate professor of industrial engineering, Columbia University, and consulting engineer, transportation and facilities branch, marketing research division, U. S. Department of Agriculture.

Flow process charts and flow diagrams aid in visualizing the complexity of the processing, the steps involved, and the dispersion and relationship of operations and other activities. Either or both of these analytical techniques might be used for a particular study. They will solve no problems of themselves but they are an aid in the analysis and the solution of problems. They present a bird's-eye view of the activities under consideration.

The activities mentioned above are portrayed by five symbols (Fig. 1) that have been standardized by the American Society of Mechanical Engineers* and are described as follows:

Operation (circle). An operation occurs when an object is intentionally changed in any of its physical or chemical characteristics, is assembled with or disassembled from another object, or is arranged or prepared for another operation, transportation, inspection or storage. An example would be the shelling of peas.

Transportation (arrow). A transportation occurs when an object is moved from one place to another, except when such movements are caused by the process or by the operator at the work station during an operation or an inspection. An example would be moving hay from the field to storage.

Inspection (square). An inspection occurs when an object is examined for identification, verified for quantity or quality, or measured in any of its characteristics. An example would be the grading of eggs.

Storage (triangle). A storage occurs when an object or product is held or kept in one place to restrict unauthorized removal, for conditioning, or for accumulation. An example would be the storage of grain.

Delay (capital letter "D"). A delay is enforced idleness which occurs when conditions do not permit the immediate performance of the next planned activity.

These symbols are the basis of a graphic shorthand used for describing the activity under analysis. At times two activities may occur concurrently such as the grading and sorting of hogs at a cattle auction market. In this case the two activity symbols, inspection and operation, are superimposed one on the other.

Once the information has been collected and the charts prepared, the engineer is in a position to make an analysis and develop improvements. Through long experience, industrial engineers have found that, when a series of questions are raised and answered about every detail of the activity being studied, ideas for improvements are often suggested. The following questions should be asked:

WHY is it necessary? Can it be eliminated?

WHAT is its purpose? Could previous processes, operations, etc., be changed to eliminate the necessity of work or reduce the amount of it?

WHO should do it and who could do it better at less cost? Is the right person doing it?

WHERE should this take place? Could it be performed better or more economically somewhere else? Should it be combined with work done elsewhere or should part of the operation or activity be separated?

WHEN should this be done? Could it be done more advantageously at some other time? Should the sequence be changed?

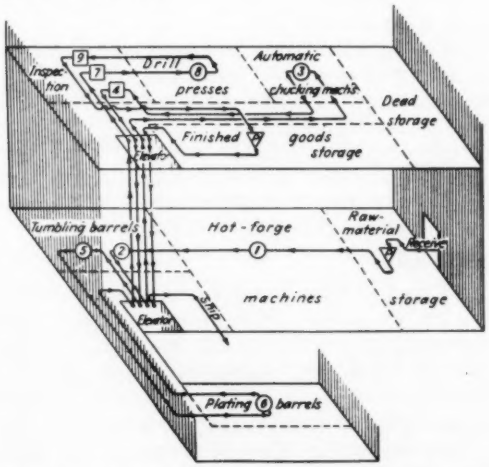
HOW should this be done? Can it be done better with different equipment, method, or layout? Can it be simplified?

With particular reference to all transportation symbols which deal primarily with materials handling, the following questions should be asked: Can transportation be eliminated or distances shortened by a rearrangement of the layout or change in the sequence of operations? Can backtracking be eliminated or reduced? There should be a direct movement of materials through a minimum distance. Should a different type of materials-handling equipment be used?

As for storages, particularly between operations, can they be eliminated or reduced? Can storage locations be changed advantageously? If speed of processing is important, this must be studied.

From an over-all point of view, the following questions will prove helpful: Are certain operations or activities de-

* For additional information refer to "ASME Standard; Operation and flow processing charts," American Society of Mechanical Engineers, N. Y. (1947).



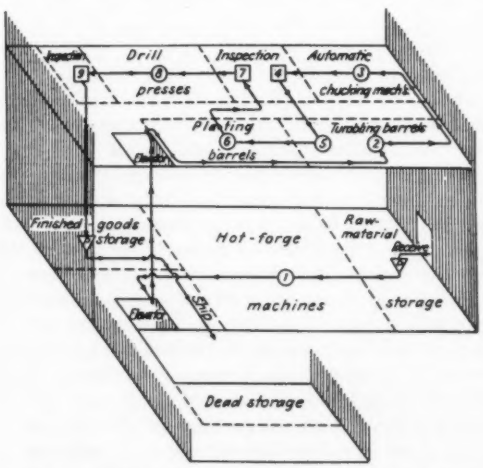


Fig. 2 *(Left)* Typical flow diagram — old method — emphasizes the existence of backtracking and long hauls of material. • Fig. 3 *(Right)* Revised flow diagram shows how the new layout serves to minimize the distance material must travel

laying the process through bottlenecks and how can they be eliminated? How can interruptions be avoided? Are there exceptions to the general flow of work? What are their causes and can they be eliminated? Lastly, can the processing or materials-handling equipment be improved, or can better equipment be more profitably substituted?

The questioning attitude is the heart of the engineering analysis. It is a terrific aid in developing ideas and solutions! These questions must be asked searchingly and repeatedly. A satisfactory answer for each question must be obtained if improvements are to be effected.

After an analysis has been made and solutions developed it is often profitable to prepare a new flow process chart or flow diagram to see how all the changes integrate. Again, the questioning attitude is brought to bear on these new charts to assure that no opportunities have been overlooked. They also serve as a comparison of the activity before and after the research study was undertaken.

Measurement Techniques

In appraising or evaluating two or more alternatives that are under consideration for improving a particular operation or activity, some form of measure of their relative efficiency or effectiveness is necessary for good decision making. At times, the preferable solution is obvious. However, this obviousness can be misleading! This is especially true where machinery is substituted for labor and the output thereby increased. The only positive basis for decision making is unit cost, whether this cost is on a per ton, per 1000 boxes, per 100 gallons, or other basis. Unfortunately manhours of labor and the various factors of equipment monetary costs cannot be added to obtain meaningful results. Furthermore, the mere conversion of observed over-all manhours into monetary costs by the application of hourly wage rates and then adding the result to equipment costs will not of itself develop reliable comparisons between alternatives. Under these circumstances, there is no taking into account the effectiveness of labor's effort, or of idleness, or misdirected effort. For reliable decision making, the effectiveness of this variable labor ingredient must be stabilized among the alternatives under consideration. The most economical and relatively reliable technique for measuring the labor ingredient available to the engineer is time study, despite some of its inherent weaknesses.

Time study is used to determine the time required by a person suited to the job and skilled in the work to perform the job if he works at a normal pace. In using this technique the task is broken down into its elements, and all elements, whether productive or not, are measured with a stop watch. The presence and amount of idle time or misdirected effort in a task cannot be detected by simply taking the over-all elapsed time; each element of the task must be carefully observed, the elapsed time for performing each element recorded and the occurrence of waste time and reasons for them especially noted. In working up the time study, those elements not directly applicable to the task are eliminated. Another product of time study, as a result of breaking down the operation or task into its elements and timing each, is that it makes possible the accounting for the way every moment of time is spent. Where waste and misdirected effort are revealed, there is an opportunity for methods improvement.

The time required to perform an operation is influenced by the skill and effort of the operator and this varies from operator to operator. Therefore, before two alternatives can be compared with respect to time and consequently labor requirements, the difference between the operators working on the alternatives must be taken into account. This is done by "leveling" which is the correcting of the observed times for departure from a normal performance. The leveled time represents the time that would be taken if the operator performed at a normal pace.

When personal fatigue and other necessary allowances are added to the leveled elemental times, the result is the time that an operator skilled in the task and working at a normal pace would take. Using this technique, the engineer can be assured that there is a proper accounting for the labor ingredient applicable to each of the alternatives.

Work Sampling

Work sampling or ratio delay is another analytical technique for obtaining information about the performance of equipment and labor in a variety of activities. It is a random sampling statistical technique for obtaining data about equipment utilization, the activity of labor or work crews and the percentage of down or idle time and their causes.

Using this technique, observations are made of an activity at preselected random times, and by figuring simple percentages of the various categories of productive time and non-productive time, an engineer can ascertain the magnitude and importance of each to the total time for its activity. With this information it is possible to pinpoint trouble spots or inefficiencies in an operation for improvement.

Work sampling requires neither complex mathematics nor the services of a skilled statistician. The observer passes the work stations at random intervals. Each time he passes some predetermined spot he notes what is occurring on a prepared check sheet. This check sheet, which must be prepared for each study, contains columns divided into the expected productive and non-productive categories based upon the purpose of the study. The percentage that each bears to the total observations will indicate the magnitude. For more exact figures consult a text on work sampling. The observations should be made randomly throughout all hours of the working day.

Work sampling is no substitute for time study in measuring labor productivity as it is a technique for breaking down a given span of time into productive and non-productive times at the level of performance at which they occur. It does not take into account the skill and effort of labor as in time study. However, it is an excellent analytical technique for gathering information relative to the importance of the various segments of an activity under study.

Cost Analysis

While time study and work sampling can measure the time activity of labor and equipment per unit of output, it is necessary to convert both into monetary terms on a unit cost basis for meaningful comparisons and appraisals. The labor ingredient can be converted by applying a wage rate to the labor time required. However, equipment costs are composed of several factors in relation to time or activity. These factors are segregated into two major categories, i.e., ownership or fixed costs and operating or variable costs.

The ownership costs are due and payable whether the equipment is shut down or operating at full capacity. Among them are taxes, insurance, interest, and depreciation. The first three are definite and fixed while depreciation is subject to engineering appraisal based on hours of activity, operating environment and changing technology. When these costs are developed on an annual basis and divided by the estimated annual number of hours of use, a per hour ownership of fixed cost figure results.

The operating costs are those that rise and fall directly with the activity of the equipment or process and are made up of such items as power, maintenance, and repairs. These costs, on an hourly basis, when added to hourly ownership costs determines the total hourly cost of the equipment. When this hourly rate is applied to the time that the equipment is used, the equipment cost ingredient is determined.

This determination of hourly cost is the most accurate method for adequately absorbing costs arising from the use of equipment with due consideration to its use or scale of operation.

Quality

In evaluating equipment and methods used for agricultural products due consideration must be given to the maintenance of quality. Some products deteriorate in quality more with one type of equipment or method than with others. It is therefore necessary to establish the quality level before and after the product is exposed to the various equipments under consideration and if possible give monetary consideration to the change in quality. This loss, on a per unit basis, should be added to the labor and equipment costs discussed above to make valid efficiency comparisons. Where monetary considerations cannot be assigned to the loss in quality, the change in quality level must be appraised in the light of the benefits to be derived from improved efficiencies.

Equipment Improvement

To bring about improved efficiencies it is important not to accept complacently the existing process, methods or equipment, as found in the environment under study. It is necessary to become familiar with the latest state of applicable technology even to the extent of investigating other fields or industries. Sources of this information are technical journals, trade papers and magazines, equipment manufacturers, trade associations, and firms in other fields who perform similar operations.

Scale of operation influences the type of equipment that can be selected economically and for the type of equipment designated a specific capacity must be selected. In selecting equipment, capacity consideration must be given to immediate needs and future expansion. Few facilities remain stable in size, they either grow and progress or shrink and die out.

Ownership or fixed costs are best absorbed at capacity operation. However, in many cases, modest increases in capacity can be obtained in a given piece of equipment at a nominal increase in cost. This is often cheaper than the purchase of an additional machine to bring about this difference in capacity when required. The ownership and operating costs of one unit of a given capacity are generally less than those of several units required to match this capacity. Where a critical operation is involved it may be desirable to distribute this capacity among several units so that the failure of one will not shut down all operations.

Materials-Handling Principles

The preceding portion of this paper developed a combination of engineering techniques for making quantative analysis to compare the efficiency or effectiveness of two or more alternatives. The analysis applies to materials handling, processing, storage and other activities.

Materials handling is the arterial system over which the life blood of agricultural products flow on the farm and from the farm to the consumer. It might be defined as the picking up and putting down, moving of materials and products in any plane or combination of planes, by any means, and it includes storage and all movements except processing operations. It not only includes movement between processing operations, but includes railway, water, airplane and highway movement. When considering the funds expended for all operations involved in processing and distributing farm and food products from source to destination, it is amazing how much more is expended for materials handling than processing. The channels of distribution are practically pure materials handling. There is little to no change brought about in the basic product. Most processing facilities spend more for materials handling than for physically or chemically changing the product. Most warehousing is nothing but pure materials handling.

The engineer engaged in materials-handling research is limited only by his ingenuity and resourcefulness. There is an infinite variety of commercial equipment available on the market today. In some cases commercial equipment must be altered and adapted and in some few cases new equipment must be designed and developed.

It is amazing the number of cases where relatively inefficient equipment is used and where efficient equipment is poorly applied. This results from a lack of knowledge of the characteristics of equipment and from a poor integration of equipment and method for handling of materials.

Materials handling is perhaps as much an art as it is a science. The science nature of this activity is demonstrated by the fact that it has been possible for engineers to formulate a set of principles which represent the rules that are to be followed. These principles have been developed and tested over a period of many years, in many industries and under varied conditions. It is the application of these rules or principles to particular problems and situations that is the art. The following principles, if followed, should result in efficient and economical handling of materials.

Materials Flow Principle

The speed of materials handling is increased and costs are reduced when materials are moved as directly as—and through the shortest distance—possible from one point to another.

This principle states that materials-handling efficiency is greatest when it approaches a steady flow, with a minimum of interruptions, and a minimum of backtracking and crosshauling. The movement of materials should approach a continuous rather than intermittent flow. This should be the objective of the engineer's thinking, even if it is not completely possible, in practice, because of the nature of the activity.

In applying this principle try to eliminate batch processing and movement. Consider the operations or processes to be intergrated with the materials-handling system, and strive for continuous flow. Conveyor systems that tie several

operations together as in the automotive, radio and appliance field, are an excellent example of applications of this flow principle.

A facility layout that incorporates wide aisles or lanes, easy turns, loading platforms or areas of adequate widths and heights, and ample approaches to doorways of adequate size, permitting two units of materials-handling equipment to pass, increases the productivity of mobile materials-handling equipment, by permitting increased speed, smoother and more direct flow of work, less congestion, and safer working conditions.

Mechanical Equipment Principle

Efficiency and economy in materials handling result from using powered mechanical equipment in place of manpower whenever practicable.

The use of mechanical equipment is cheaper than the use of manual labor when the savings in direct labor costs are greater than the cost of owning and operating the equipment. However, there is a minimum volume of work above which materials can be handled more economically with mechanical equipment. This volume varies with the degree of mechanization of the equipment. Although mechanical equipment can be used to do the work faster and with fewer men than is required by purely manual or semi-mechanical means, it is conceivable that, because of the small volume of materials to be handled, the purchase of mechanical equipment could not be justified and the cost of performing the work would be increased if mechanical equipment were employed.

Where more mechanized mechanical equipment is to supplant existing mechanical equipment, first check to be sure the present equipment is used as efficiently as possible. Where new equipment is required, the simplest materials-handling equipment applicable to the task should be selected. As a general rule special or custom-built equipment should be avoided, as it is usually more expensive and has to be adapted to the handling activity with more experimentation than commercially available types. It is to be remembered that the more operations or work the mobile mechanical equipment can be used for, until its rated capacity is reached, the lower the unit materials cost will be.

Mechanical equipment offers these advantages: *(a)* work done with equipment is generally more economical, *(b)* a larger volume of work per operator is attainable, thus reducing the labor force, *(c)* greater speed in handling is obtained, and *(d)* safer working conditions result.

Unit Load Principle

Efficiency in handling materials is increased as the size of the handling unit is increased.

The unit load, as this handling unit is generally termed, is made up of several packages, containers, or items grouped together so that they may be handled as a unit for unloading, transporting, stacking or loading operations, or any combination of these operations rather than as individual packages or items. A unit load is usually considered to be a loaded pallet or skid, but might well be any load consisting of two or more packages or containers which are so set together that they can be handled and moved simultaneously or as a unit. A power scoop, skid bin or box containing bulk materials is also considered a unit load.

As the size of the load handled is increased up to the capacity of the equipment, the fewer the trips and the shorter the time required to complete the handling activity. Once a unit load is assembled, savings are brought about because many items are handled at one time rather than individually. Unit loads should be maintained until it is absolutely necessary for them to be broken up. The longer the unit load can be kept together for all handlings and carried forward into other operations, the greater will be the savings and efficiency. An example of unit-load handling would be the simultaneous unloading of 48 boxes of apples from a highway truck by means of a fork-lift type of industrial truck with a clamp attachment at an apple packing house; transporting and stacking them as a unit in refrigerated storage; taking them out of storage as a unit to the packing line; then removing them as a unit back to storage where they are stacked, and finally removing this unit load to shipping platform for loading into a refrigerated car. Here 48 boxes are handled simultaneously and as a unit through these several activities.

Unit loads, in addition to reducing the number of individual handlings and trips required, simplifies inventory taking, since the number of unit loads multiplied by the number of units gives the stock on hand. The use of unit loads and fork-lift trucks increases the storage capacity of a facility by permitting stacking of one load upon another. Lastly, unit loads reduce the amount of spoilage resulting from picking up and dropping individual packages because of the reduced number of handlings.

Balanced Handling Principle

Economy in handling materials is obtained when, in operations involving crews of workers, the men and equipment are assigned in accordance with the minimum number of men required, and their work is so arranged that delay time and total men-hour requirements are kept to a minimum.

To do a job well, a balanced crew and equipment are of utmost importance, since in most instances the productive work performed by one crew member depends on the work done by other crew members. Thus, if there are too few workers employed at one phase of the activity, a great deal of time will be lost through waiting at another phase of the task, thereby increasing the cost for the entire activity. Unbalanced handling operations will always result in bottlenecks. Idle crew men, waiting on other materials handlers, are positive evidence that the work load is not properly distributed throughout the activity.

Flexibility Principle

The greater the variety of materials-handling operations for which a particular type of equipment can be used, the greater is its value for materials-handling tasks.

All equipment and methods should be designed, where possible, to permit economical operations under changing conditions. This is especially true when a piece of equipment cannot be used full time on a specific task. The ability for it to be moved and adapted to other tasks brings about greater utilization and reduced unit-handling costs.

The fork-lift truck with its many attachments is a prime example of this flexibility. Their attachments include a shovel or scoop for bulk materials, clamps for cubical and cylindrical packages, crane for lifting and hoisting, revolving forks for dumping or inverting, and many others for specialized tasks. A farm tractor with power-operated scoop,

fork, etc., is another example. Portable conveyors have a lesser degree of flexibility.

Equipment Velocity Principle

The economy of materials handling is usually increased as the velocity of the handling equipment is increased.

The greatest value is obtained when equipment is used to, but not in excess of, its full rated capacity. When operated at less than rated speed, for the commodity handled, production suffers and unit-handling costs increase. However, equipment should never be operated at such a speed or in such a manner as to create safety hazards.

Equipment in Use Principle

Economies in handling materials are increased by decreasing the proportion of idle time to use time of the handling equipment.

A unit of equipment is productive only when it is in motion. Using poor methods that increase the time to load or unload mobile equipment increases idle time and costs. It is to be remembered that just as workers who are on hand must be paid regardless of whether they are assigned work to perform, the cost of owning the equipment continues regardless of whether the equipment is used.

An example of this principle is the loading of cased canned goods into a straight highway truck. Two tons, made up of 390 cases on skids (unit loads), were loaded onto the truck in five minutes by one man with industrial platform lift truck where it formerly took 45 to 60 min. for two men with hand trucks, moving five cases at a time. The reduction in idle time for the straight truck during loading made it possible for the truck to make more trips. The truck was designed for moving materials and not for the temporary storage of materials!

Performance Principle

The economic performance of materials-handling equipment is determined by the comparative expense per unit of materials handled.

The mechanical features of a piece of equipment should not be the only criteria for selection. Usually several types of equipment, be they farm tractors, conveyors, fork-lift trucks, cranes or others, are capable of performing the task. Each will have its own characteristics with reference to speed, cost, maintenance of product quality, mobility, man-power requirements, etc. Therefore, equipment selection must be based on dollar performance rather than mechanical performance if maximum economy of time, manpower, and money is to be obtained. The relative efficiency for performing the task is measured in cost per unit handled whether this be tons, gallons, bushels, packages, or other units of measure.

Equipment Replacement Principle

Economy in handling materials is increased by replacing handling equipment with more efficient equipment, when the savings affected are large enough to pay for the cost of replacement within a reasonable period of time.

Before replacing equipment, it is necessary to make certain that the present equipment is being used as effectively as possible, and that the new equipment be even more efficient.

The strides that are being made today in developing new equipment and improving existing types hasten obsolescence. Also, a major new development in processing can obsolete existing materials-handling equipment. An increase in the scale of operations of an enterprise opens up the possibility for using more mechanized equipment economically.

It is as a result of this continual change that it is necessary for the new equipment to pay for itself within a reasonable period of time out of the savings it makes possible. What is a reasonable period of time can only be determined by appraising the rate of change within the enterprise, and the services it renders together with the rate of development of new processes and materials-handling equipment. It is generally unreasonable to expect new equipment to pay for itself in one year except where change is very rapid; to do so is to deny improvements and savings that are worthwhile and cumulative from year to year.

Safety Principle

The productivity of materials-handling equipment is increased with safe working conditions.

The protection of employees from possible injury is more than a humanitarian act; it is a means of lowering handling costs. When an employee is injured not only are his services temporarily lost, but the services of those who come to his assistance and those who collect out of curiosity are also lost. Some of management's time is diverted investigating and preparing accident reports as well as attending inquests. A severe accident has a demoralizing effect on all employees, they become overcautious, and their productivity suffers. In addition to these costs there are payments and benefits to the injured employee which are in turn reflected in liability insurance costs.

The equipment selected for materials-handling operations should afford proper protection to the employee and to the equipment. The facility should be well laid out and have adequate lighting to minimize accidents. Materials-handling operators should be properly instructed in the use of equipment and safe handling methods.

Facility Layout Principle

Facility layout has a direct influence on the efficiency of materials handling.

Facility layout is an intergration of equipment, materials, work centers, or other floor or work areas, materials handling, and labor for the purpose of achieving an efficient and balanced arrangement for processing a product or supplying a service. A good facility layout aids materials handling while a poor layout often denies the use of the most effective materials-handling equipment and methods. When a new facility is to be erected, there are limitless opportunities to develop a layout that facilitates materials handling. However, the usual case involves an existing facility with its limitations on both layout and materials handling.

A good layout facilitates materials handling by arranging the process for a smooth and direct-line flow of materials, provides adequate aisle or alley space for materials movement, minimizes congestion for using materials-handling equipment, has properly located loading platforms of proper height and width, has working areas of proper size, and provides safe working conditions.

Storage areas should be of adequate size, located in the line of flow of the materials and permit the use of its cubic contents rather than its square feet of floor area by suitable materials-handling equipment.

INSTRUMENT NEWS

KARL NORRIS, Editor

Sponsored by the ASAE Committee on Instrumentation and Controls. Contributions on agricultural applications of instruments and controls and related problems are invited, and should be submitted direct to K. H. Norris, South Wing, Administration Bldg., Plant Industry Station, Beltsville, Md.

Continuous-Recording Wet-Bulb Apparatus

Robert A. Saul
Assoc. Member ASAE

THE study of grain drying with natural or unheated air at the U. S. Department of Agriculture grain-storage laboratories located at Iowa State College, Ames, Iowa, has introduced the need for a continuous record of the wet and dry-bulb temperatures in order to have a knowledge of the drying potential of the air used in drying. There have been several methods proposed for wet-bulb measurements, some of which have been reported in AGRICULTURAL ENGINEERING. Methods previously reported (1, 2)* use a thermocouple enclosed in a cloth wick which is kept saturated with water with air blown over this wick to obtain the wet-bulb temperature. This method can be used successfully to obtain the adiabatic saturation temperature of the air when the factors of radiation, heat transfer and air velocity are taken into account as they were in the two apparatuses mentioned above. One difficulty in such methods is the problem of maintaining a wet surface and feeding water to the wick without disturbing the system.

Instead of using a single wick surrounding a thermocouple, we have successfully used a deep bed of vermiculite which is easily kept wet. This was accomplished by filling a 20-gal galvanized can to a depth of approximately 12 in with vermiculite as is shown in Fig. 1 . A 2-in pipe extended from the top of the can down to a plenum chamber formed of fly screen in the shape of a cone which was about 6 in high and had a diameter at the base of about 8 in. Air was forced up through the vermiculite either by blowing air down the pipe or sealing the top of the can with the inlet pipe extending above the seal and connecting a blower intake to the space above the vermiculite. This latter method is preferred because it eliminates any addition of heat due to the blower. A thermocouple was located approximately 2 in above the cone and the same distance from the pipe. A drain hole was located 2 in above the bottom of the can and water was poured into the can either down the pipe or down the side of the can until it reached this level. A small blower was used to force the air through the vermiculite at the rate of approximately 35 cfm. There was enough movement of the water up through the vermiculite to keep it wet even with this rate of air flow. During hot dry weather there was enough water to last for 48 hrs or more. A large supply tank could be incorporated to extend this time.

In this system the thermocouple senses the temperature of the air and vermiculite. In a deep bed such as this, the air passing through the wet material, and the material itself, both tend to stay at the wet-bulb temperature as long as free water is available for evaporation. By using an air-flow rate that assures a substantial portion of the depth at wet-bulb temperature and by having sufficient volume of wet material to prevent the central portion being influenced by heat transfer from the surfaces, adiabatic equilibrium is maintained.

The purpose of the readings was to get an average wet-bulb temperature over a period of time. For this purpose any lag due to fluctuating atmospheric temperatures was unimportant. It was observed, however, that the lag effect could not be detected even when checking individual readings with a hand aspirated psychrometer.

T. E. Hazen of the Iowa State College department of agricultural engineering has used this method in a 1-gal round can with the same success obtained in the larger model. He estimated the rate of air delivery through the vermiculite to be less than 5 cfm. Readings from both apparatuses were recorded with a Brown recording potentiometer.

Paper prepared expressly for AGRICULTURAL ENGINEERING. Approved as Journal Paper No. J-2927 of the Iowa Agricultural Experiment Station, Ames. Joint contribution of the agricultural engineering department, Iowa State College and the Agricultural Engineering Research Branch (ARS), U. S. Department of Agriculture.

The author—ROBERT A. SAUL—is assistant agricultural engineer, U. S. Department of Agriculture.

*Numbers in parentheses refer to the appended references.

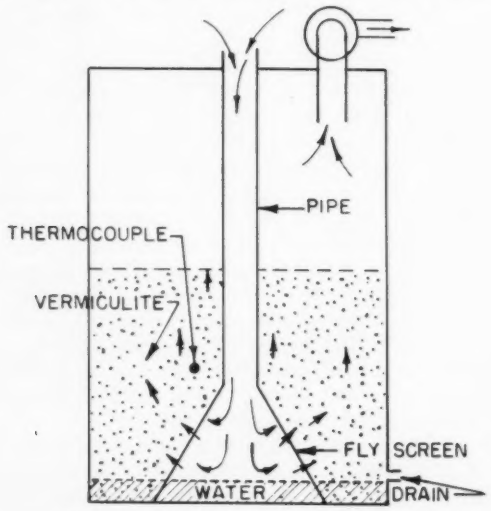


Fig. 1 Schematic diagram of wet-bulb apparatus

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1 Henderson, S. M. A constant-feed all-temperature wet-bulb. AGRICULTURAL ENGINEERING, vol. 33, p. 644, October, 1952.

2 Haynes, B. C., Jr. and Smith, L. L. Psychrometric equipment for recording potentiometers. AGRICULTURAL ENGINEERING, vol. 36, p. 192, March, 1955.

Zinc Die Casting Use Increases

THE American Zinc Institute reports that an increase in the use of zinc die castings places a new demand on zinc production in the United States.

Approximately 350,000 tons of special high grade zinc were used in 1955 for zinc die castings. These castings are used in a host of products ranging from umbrella rib tips to spin tub balance rings for automatic washing machines. The automobile industry uses zinc die castings for radiator grilles, hood ornaments, letters, headlamp moldings, door frames and handles, carburetors in addition to many other functional and ornamental parts. A gasoline lawn mower may use as many as 38 zinc die castings; a lock set may use 16.

TECHNICAL PAPER ABSTRACTS

Following are brief reviews of papers presented at ASAE meetings. Information concerning complete copies of these papers may be obtained by writing to the American Society of Agricultural Engineers, St. Joseph, Mich.

A Concrete Block House Using Liquid Adhesives, by M. A. Sharp, head, agricultural engineering dept., University of Tennessee, Knoxville. Presented at annual meeting of ASAE at Roanoke, Va., June, 1956, on a program arranged by the Farm Structures Division. Paper No. **56-1.**

A new type of concrete block made with recently developed expanded shale was designed, tested, and used in construction of an all-concrete experimental house at the University of Tennessee. The paper describes the blocks and explains a method of laying the blocks with liquid adhesives instead of sand mortar. These adhesives are said to have a tensile bond strength of about ten times that of sand mortar. They may be laid up very quickly by unskilled labor. When the air spaces are filled with loose fill insulating material, the wall has a very high insulating value. The author suggests that if this type of construction proves to be as good as preliminary observations indicate, it may make possible comfortable, permanent, low-cost homes built with unskilled labor.

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Developments in the Measurement of Milk in Bulk Tanks, by A. K. Gillette and C. W. Hall, respectively, agricultural engineer and professor of agricultural engineering, Michigan State University, East Lansing. Presented at annual meeting of ASAE at Roanoke, Va., June, 1956, on a program arranged by the Rural Electric Division. Paper No. **56-2.**

Accuracy in calibration devices for milk in bulk tanks is discussed in this paper. Of nearly 100 bulk tanks checked on farms a few months after installation 32 percent were still in accurate calibration, while 36 percent were in error 1 to 3 lb, 17 percent in error 4 to 9 lb, and 10 percent in error 10 to 15 lb. The meniscus was found to vary considerably with different pouncing materials. Reading errors are involved from stirring milk, improper seating of graduated rod, and poor driver habits.

Other devices now being used to determine the quantity of milk in a bulk tank are discussed. The importance of assuring that the tank is not shifted after calibration and methods of maintaining the position by floor design are also covered. Other factors discussed are the doorway design, electrical service provisions, and other building features. The effect of varying butterfat and holding temperature will be related to calibration. Research needed in the field of milk measurement is presented.

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Routing Through Tide Gates, by Paul D. Doubt and G. E. Oman, civil engineers, design section, engineering division, SCS, USDA, Beltsville, Md. Presented at annual meeting of ASAE at Roanoke, Va., June, 1956, on a program arranged by the Soil and Water Division. Paper No. **56-3.**

A method of determining the size of outlet required to prevent inundation of land in diking systems above a stated elevation, or to determine for a selected pipe of standard size the highest elevation at which inundation will occur, is presented in this paper. The method does not attempt to predict the elevation of tide vs. time nor the design inflow rate, but assumes that this information has been obtained along with the storage characteristics on the land side of the dike and the rating curves of the pipe.

The article emphasizes the correspondence that exists between the elevations of the tide when the gate opens, the elevation of the tide when the gate closes, and the size of culverts. The basic equation for routing through tide gates is developed to determine the correspondence of these three quantities. An approximate method of determining this correspondence is also given.

•

Plastic Films in Farm Construction, by C. E. Staff, Bakelite Co., New York, N. Y. Presented at the annual meeting of ASAE at Roanoke, Va., June, 1956, on a program arranged by the Farm Structures Division. Paper No. **56-4.**

This paper presents a brief review of two classes of plastic films: polyethylene and vinyl. Their important properties are emphasized and commercial and experimental applications such as paulins, silage covers, canal and tank liners, mulches, vapor barriers and greenhouses are discussed. Parallel development of these materials in other industries such as home building are mentioned in order to stimulate the use of these materials in farm applications.

The author expresses an opinion that the volume of farm applications for plastic films will increase markedly in the future because plastic film applications offer low annual cost and high return for investment.

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Dollars and Cents in Farm Electrification, by J. H. Oliver, agricultural engineer, General Electric Co., Schenectady, N. Y. Presented at the annual meeting of ASAE at Roanoke, Va., June, 1956, on a program arranged by the Rural Electric Division. Paper No. **56-5.**

The application of electricity to farm chore operations for cost reduction and increased output per manhour is discussed. It reports that the progressive farm operator can make an adequate return on his investment, even at present price levels, when he uses electricity at 1 to 3 cents per hour to do a man's job.

According to the paper, electrification of the poultry industry is rapidly approaching the automation level and makes it possible for the farmer to show a profit, even with prices at a level that would have meant bankruptcy 10 years ago. The dairy industry with its 53 hours of labor per $100 of milk produced, is reported to offer the greatest opportunity for cost reduction through electrification.

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Post-War Agricultural Engineering, by J. H. Levin and C. W. Hall, respectively, agricultural engineer, (AERB, ARS), USDA, and associate professor of agricultural engineering, Michigan State University, East Lansing. Presented at annual meeting of ASAE at Roanoke, Va., June, 1956, on a program arranged by the Education and Research Division. Paper No. **56-6.**

Changes which have taken place in agriculture and how agricultural engineers through training, interest, and professional societies, can better meet the problems of and be of service to agriculture, are presented in this paper. The authors point out that in the past the problems of agriculture have dealt primarily with agricultural production and most of the attention and work have rightly been focused there, and should continue. However, they state that agriculture is now faced with many problems in product preparation—preparation for livestock feeding, preservation or for sale. New state and federal laws, demand for fruit and vegetable products, spending habits—have all placed more emphasis on product preparation. Data are presented to illustrate the changes, and thought is given as to how the agricultural engineer can help meet the problems involved in those changes.

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Development of A Sugarcane Harvester for Louisiana, by R. M. Ramp, agricultural engineer, Farm Machinery Section, ARS, USDA, Houma, La. Presented at annual meeting of ASAE at Roanoke, Va., June, 1956, on a program arranged by the Power and Machinery Division. Paper No. **56-7.**

Development of a sugarcane harvester for Louisiana conditions that has been under way since 1949 is discussed in this paper. Because harvesting sugarcane grown in Louisiana presents problems not encountered in other sugarcane areas of the world, the author reports that the Louisiana sugarcane industry requires a harvester that will remove 8 to 10 tons of trash from every 24 tons of millable cane harvested; that will have a capacity of 200 tons per 9 hours with an average of 3 percent trash or less; and that will harvest the entire field independently under wet and dry field conditions while handling either erect or partially lodged canes in one continuous economical operation.

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The Hood Inlet For Closed Conduit Spillways and Highway Culverts, by W. Blaisdell and C. A. Donnelly, hydraulic engineers, watershed hydrology section, (SWCRB, ARS), St. Anthony Falls Hydraulic Laboratory, Minneapolis, Minn. Presented at annual meeting of ASAE at Roanoke, Va., June, 1956, on a program arranged by the Soil and Water Division. Paper No. **56-8.**

The hood inlet described in this paper is formed by cutting a pipe at an angle. The long side is placed on top and forms a hood over the entrance to the closed conduit spillway or culvert of which it is a part. The hood inlet is said to cause the spillway to flow full with a very low submergence of the inlet crown. The "priming" of the hood inlet is caused by the jet which is directed upward by the sloping inlet orifice. This has been found to seal off the spillway at the hood inlet even before the inlet itself is submerged. The headpool level then increases only slowly with increasing flow until the spillway is completely full. The minimum length of the hood said to insure full spillway flow at minimum heads is three-fourths of pipe diameter. This hood length is the minimum for all conduit slopes up to 36 percent, the steepest tested.

The authors suggest that hood inlets should prove useful for many of the hundreds of thousands of closed conduit spillways used for farm ponds, flood detention structures, grade stabilization structures, surface drainage and irrigation drops, and highway culverts.

The 1956 ASAE

HARRIS PEARSON SMITH

Cyrus Hall McCormick Medals were awarded to Harris Pearson Smith and Martin Ronning

MARTIN RONNING

FROM family legend it appears that at the age of 12, and small for his years, H. P. Smith declared, "When I grow up, I'm going to throw that Georgia stock in the Bogue Chitto River. I don't believe that the Good Lord intended for anyone who has a mind to think to have to work so hard with his hands."

The Georgia stock, a one-mule walking-low frame and handles which served for a variety of simple tools for tillage and cultivation, was a symbol for all the hand tools and "hard way" implements which then were the rule in Southern agriculture. And his boyhood resolve may explain, as no one seems able to explain, how in later years H. P. Smith became generally known as "Horse Power" Smith.

It was because of his father's ill health that the burden of farm operation was thrust upon the future medalist in his tender years. It also brought his first and perhaps principal exploit in farm structures. In the summer of 1914, after finishing high school and before entering Mississippi State College, he built a modified pole barn 30 x 60 feet in size. He went out into the forest, selected fat pine logs for the post and 32-foot poles for the joists. Holes for the post were dug with a hand post hole digger. The post and the poles were handled with a 20-foot tripod hoist he built for the job.

He was born at Poplarville, Mississippi, on August 3, 1891. His parents were Andrew J. and Mary Louise (Bilbo) Smith. To his first school was a three-mile walk, with two unbridged streams on the way. Across them his father felled tall pines and hewed them flat on top, to form "foot logs." Instead of picking his perilous way over the logs he would ride piggy-back with the teacher, his Uncle Theodore G. Bilbo, later famous as Governor and U.S. Senator.

His higher education was at Mississippi State College, where he earned his B.S. in agriculture, specializing in agricultural engineering, in 1917, followed by M.S. in 1926 and A.E. in 1940, both at Texas A. & M. College. His first two years after graduation were with the U.S. Department of Agriculture. Then, in 1919, began his connection with Texas A. & M. College and its associated Experiment Station which continues to this day.

Interrupted only by a leave of absence to serve in 1950-51 on an advisory commission to the Minister of Agriculture of Turkey, he has been associate professor, division chief in the Experiment Station in charge of research, and professor in charge of research —all in agricultural engineering. Since 1930 he has supervised graduate students doing thesis work, and since 1947 has been a member of the graduate faculty.

Despite his nickname "Horse Power," Mr. Smith has not concentrated on the tractor as such, but rather on the ultimate applications of power in the soil and most conspicuously at the cotton boll. Indeed, there is hardly a phase of cotton culture, from planting and placement of fertilizer to cleaning of the machine-picked crop, but what has taken strides ahead as a result of his varied research. As expressed by Frank B. Rogers:

"I have covered the cotton belt of America from Virginia to California repeatedly over the past forty years, and the cotton-growing sections abroad for thirty-three years, and I have met no one who, I think, has contributed as much to the effort of mechanically harvesting cotton as H. P. Smith."

First and perhaps greatest of the developments credited to him is a cotton stripper with principles now embodied in many commercial strippers. Related to it were a tractor-mounted bur extractor and a cleaner for removing foreign matter from seed cotton. He also developed a variable-depth planting device.

Leading toward better equipment and practices were his studies into the effects of fertilizer placement, soil disturbance, fur-

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WHEN he was a lad of 15, a Minnesota farm boy and his brother built a tractor, and it worked. To be sure, it was only a 5-horsepower gas engine which became self-propelled by the grace of old binder and mower wheels, chains, sprockets and pulleys. But in 1909 it was news when anybody built a tractor that worked.

For Martin Ronning it was augury of a career concerned largely with harvesting machines and their parts, the early workings of a mind which was to create an idea whereby a single engine and set of wheels would serve for a whole array of self-propelled machines for all the major harvesting operations. It led from the pioneer homestead to Mexico, Argentina, Europe and other lands, each with its special crops and conditions to challenge his talent.

A farm near Dalton, Minnesota, was his birthplace and October 15, 1894, his birth date. His parents were Ole and Anne (Boen) Ronning, both natives of Norway. In a bit of their 240-acre farm was the Dane Prairie School where Martin, his two sisters and six brothers, as well as neighboring children started their educations. He attended high school at Fergus Falls.

Martin Ronning got his higher education the hard way. He had been a cowboy with a brother homesteading in the Black Hills of South Dakota. In World War I, he was stationed at Camp Grant, near Rockford, Illinois, and it was Martha Schoepp of Rockford whom he married in August of 1919. While there he had taken a job as lathe hand, but in 1920 returned to help with the home farm, then went to work as a machinist in Minneapolis.

For a couple of years he had been pursuing courses with the International Correspondence Schools, and in 1921 made bold to ask for a job as draftsman with William Bros Mfg. Co. of Minneapolis, boiler builders. Through the five years that he worked there he studied engineering in evening classes at the University of Minnesota extension division. It was on one of those

Gold Medalists

The American Society of Agricultural Engineers Awards Annually the Cyrus Hall McCormick Medal for "Exceptional and Meritorious Engineering Achievement in Agriculture" and the John Deere Medal for "Distinguished Achievement in the Application of Science and Art to the Soil." Presentations of the 1956 Awards Were Made During the Society's 49th Annual Meeting at Roanoke, Va., June 19.

The John Deere Medal was awarded to Arthur W. Clyde

ARTHUR W. CLYDE

nights that he slept to the end of the streetcar line, far in the suburbs, whence he had another hour's ride back.

Then, in 1927, he saw and answered an advertisement for what today would be called a project engineer. It promised a chance to work out his boyhood dreams and ambition for the advancement of farm machinery. And so he joined the Minneapolis Threshing Machine Company for its transition from threshers to combines.

It was a task for which he had both zest and background. When 14, he had joined the threshing crew of an older brother, working all the positions including that of firing with straw, until at 19 he was the "engineer." But he had shared with his brother the bitter experience of losing jobs to a rival thresherman who claimed to do better work with his Minneapolis machine. Henceforth he was to work with, not against, Minneapolis.

His opportunity soon broadened. In 1929, the firm merged with Minneapolis Steel and Machinery Company, builders of tractors, and Moline Implement Company, manufacturers of tillage equipment, to form a full-line concern. At first called the Minneapolis-Moline Power Implement Company, its name was, in 1949, shortened to Minneapolis-Moline Company.

In perspective, his career with the company has been one of such steady progress as to be more monotonous than dramatic—succession of machine models, a series of machine elements. He balanced combines over a single axle, eliminated the front-wheel assembly and in other ways reduced weight. He devised a single-unit feeder and separator. He designed combines in cutting widths from 69 inches to 14 feet. He created an automatic wire-tie hay baler in 1946, and earlier had advanced designs for large and small sizes of the long-famous Minneapolis corn shellers.

A dramatic exception is Mr. Ronning's concept of diverse self-propelled machines

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WHOEVER it was who said, "Engineering is mostly common sense with mathematics," might well have been thinking of Arthur W. Clyde. Certainly few men have been able to keep their feet so firmly on the ground of practical engineering applications and at the same time guide every step by the principles of mechanics. Add a talent for making mathematical concepts less mystifying, and you see at least one side of the 1956 John Deere Gold Medalist.

Son of Jefferson F. and Harriet Clyde, he was born March 30, 1891, at Osage, Iowa, and there had not only his elementary and high school education but a year of liberal arts at Cedar Valley Seminary. Then came an experience such as inspired other notable engineers. He got a job on a project to take a tractor to North Dakota to break virgin prairie and seed it to flax. His work with that pioneer Hart-Parr 22-45 led him to enroll in agricultural engineering when he entered college.

That was at Iowa State College, where he received the bachelor's degree in 1915. Then came three years of work for the International Harvester Company at Fort Dodge, Iowa, in sales and service, followed by two years with the Portland Cement Association of Chicago, doing engineering and promotional work on farm uses of concrete.

In 1920, Mr. Clyde returned to Iowa State College as extension agricultural engineer. Besides the usual duties of that job he did experimental work with barn roof trusses, assisted in developing the famous Iowa traction dynamometer, and along the way earned his M.S. degree, conferred in 1931.

In the same year he went to Pennsylvania State College, now Pennsylvania State University, as associate professor and then professor of agricultural engineering. He was acting head of the department from the first of 1952 to August of 1954. He has done some undergraduate teaching and conducted graduate courses, but his major responsibility has been research.

Seldom, during these years, has his research been away from the smell of the soil, and then mainly to the aroma of new-mown hay and other forage. To a degree more literal than most of its donees, Clyde fulfills the inscription of the John Deere Medal, "For Distinguished Achievement in the Application of Science and Art to the Soil."

All along, an abiding motive has been the correct application of mechanics to tractors and implements. A quarter-century ago little was really known about the soil reaction forces on tillage tools, notably their side and vertical components. And so he built and used the tillage meter, the first apparatus in the country for measuring in three planes the resistance encountered by various soil-working tools.

With its aid he has exploded some traditional beliefs about the hitching of implements, and also about their design. He found that the classical center of resistance in moldboard plows, inherited from the simple walking plow, had little meaning with modern wheel-borne and tractor-mounted plows. The offset disk harrow, too, was impossible of analysis until there were definite data on the way that soil resistance responded to changes in disk size, angle, and weighting.

Data from the tillage meter, together with Mr. Clyde's relentless insistence on complete resolution of forces, resulted in his authoritative analysis of what happens with all the superficially similar but basically different types of three-point linkages used for rear-mounted tractor implements. From all these studies have come not only revised instructions in textbooks, educational bulletins and manufacturers' manuals but advances in implement design.

Still in the soil, and especially the stony soils of Pennsylvania, was his research into theory and practical devices for dissipating kinetic energy when a plow strikes an obstacle. He studied springs, hydraulic cylinders, and combinations thereof. He probably was first to sense the peculiar value of hydraulic cylinders for this purpose. He not

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Harris P. Smith

(Continued from page 490)

row openers, covering devices and press wheels, seed-dropping mechanisms and thinning methods, chemical methods of weed control, nozzle-type and arrangement in insect control, and storage of seed for planting.

He gave attention to garlic, too, devising a digger and two types of driers for heated and natural air. He developed methods whereby millions of acres of ranch lands were cleared of prickly pear. His quest for quality in peanuts led to changed design in peanut combines. For twenty years he has been studying the rate of corrosion of wire as affected by atmospheric exposure.

As an author, Professor Smith is famous for his book "Farm Machinery and Equipment," widely used as a college text in this and other countries. First published in 1929, it has come out in other editions in 1937, 1948, and 1955, with a Spanish edition in 1945. Of it, a colleague in a neighboring state says, "The author has been more alert in revising and rewriting his book than has any author in his field."

Of Texas Agricultural Experiment Station bulletins, circulars and progress reports, Professor Smith's name appears as author or co-author of some 35 titles. Among 96 articles he has written for farm, trade and technical publications and reference works are nine feature contributions to AGRICULTURAL ENGINEERING.

His membership in ASAE, dating from 1920, includes service on its Subcommittee on Fertilizer Application. He is a member of the American Society for Testing Materials and councilor for its Southwest Section. Other memberships include the Association of Southern Agricultural Workers, Steering Committee for the Belt-Wide Cotton Mechanization Conference, and the Regional Technical Committee on Cotton Mechanization.

He is a registered professional engineer in Texas, member and vice-chairman of the Texas Library Natural Resources Board, was consultant to the War Production Board in 1945, and collaborator for the Southern Research Laboratory in 1948. Local and fraternal connections include Tau Beta Pi, Phi Kappa Phi, Brazos Union Lodge 129 AF and AM, Knife and Fork Club, and the First Baptist Church of Bryan.

During their sojourn in the Near East, Professor and Mrs. Smith sought out the ruins of the Seven Churches of Asia Minor, as mentioned in the Book of Revelation. Applying his hobby of photography, he secured some six hundred color slides and many hundred feet of movie film. These have given him material for dozens of pictorial lectures to clubs, conventions and religious assemblies.

Also stemming from his experience in Turkey has been a bond of goodwill with the people of that country, and especially of fatherly friendship for Turkish students who have come to Texas A. & M. His own sons, Harris P. Jr., and Robert S., are respectively, a designing engineer of Houston, Texas, and a lieutenant in the U.S. Navy.

Martin Ronning

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without duplication of power and propelling parts. In his duly attested sketches of April 6, 1945, he does not use the term "tractor," but designates his dream as a "self-contained, self-propelled unit." These sketches include, as examples, the embodiment of a combine and of a two-row corn picker. Besides them, the Uni-Farmor family now includes a picker-sheller, a forage harvester with row-crop, pick-up and direct-cut headers, a hay baler, and a windrower. Additional units in preparation are a grain drill and other machines.

The basic unit, the "Uni-Tractor," has intrigued others. For use with it is a John Blue anhydrous ammonia applicator, a manure spreader by United Implements, and custom foragers by Western Land Roller Company and Fox River Tractor Company, and a sugar-beet harvester by Oppel Harvester Company, Boise, Idaho. The 1955 Class of Iowa State College made a class project of designing and building a moldboard plow for the "Uni-Tractor."

In farm safety, Martin Ronning is a legendary figure. From its outset some 20 years ago, he has served on the farm section of the Minnesota Safety Council and has also served on the farm conference of the National Safety Council for about 12 years. He completed a term as chairman of the conference in 1955 and is at present a member of the council's board of directors.

Dovetailing with this is his activity in the advisory engineering committee of the Farm Equipment Institute, to which he was named in 1940 and wherein he serves as chairman of the implement section. Largely through his tireless effort the FEI recommendations on tractor and implement lighting were formulated and embodied in the national Motor Vehicle Code.

Besides ASAE and his activities in safety and in the FEI, Mr. Ronning is a member of the Society of Automotive Engineers, the Minnesota Federation of Engineering Societies, Engineers Club of Minneapolis, Minneapolis Athletic Club, and past-president of the Rotary Club of Hopkins, Minnesota.

Of Mr. Ronning's writing there is no bibliography. Despite notable papers before professional meetings, plus articles in engineering, farm and trade publications, he never bothered to maintain a file or record.

In contrast with his clear-cut professional career are conflicting reports as to his personal proclivities. Some tell how he long has been landlord to families of martins, and how in the heart of the city he has ten or fifteen pheasants as guests at feeding time. Others talk of his fishing forays in the lake beside his cottage in northern Minnesota. But lake neighbors complain that he has made the fish so safety-conscious that they won't bite bait.

With a birthright of the language direct from the old country, plus a rich background of its impact on English, Martin is famous for his rare Norwegian stories. His Spanish, picked up in Latin lands, betrays the latent emotion which his English disguises. Often considered a somewhat reserved and reticent figure, he blossoms into full flower in the Romance languages. In any language, he is equally at home with dignitary or dirt farmer, in front of a forum or over a wire fence.

Arthur W. Clyde

(Continued from page 491)

only built several such devices, but also published the principles thereof for use by the entire industry.

In addition, Professor Clyde has taken brief leaves of absences for specific projects with individual companies. He worked with Allis-Chalmers on built-up plow beams and on cushion hitches. For John Deere he studied certain phases of tractor stability. He also built a model tractor for demonstrating what makes tractors upset in various conditions, and by its presentation to farm and youth groups made substantial contribution to farm safety.

In the famous Ferguson-Ford patent litigation he won acclaim for the clarity with which he unraveled the complex technicalities involved. At one stage, tests were planned to prove performance when the plow struck an obstacle. One of the lawyers proposed to put down two steel plates, spaced like the plow bottoms. He still chuckles at Art's comment, "Back in the hills of Pennsylvania our rocks don't come in pairs like that."

Few men in research have been so faithful, and so effective, in making known their findings. Among more than fifty bulletins and articles of which Clyde is author or co-author, over a score are Journal Series articles of the Pennslyvania Agricultural Experiment Station which have been published in AGRICULTURAL ENGINEERING along the years from 1932 through 1955.

Among his writings is a series of articles, in six successive issues of "Farm Implement News," also published in booklet form, on "Mechanics of Farm Machinery." In them he carried to a readership of farm machinery dealers and service personnel the basic principles of balance and combination of forces, as well as their application to tractor pull and stability and their occurrence in moldboard and disk implements.

In connection with his writings, he gives praise for editing assistance to Mrs. Clyde, who until 1917 was Ruth Moe and who is mother of their two sons and a daughter. Indeed, a colleague hints that Art is on his mettle to keep up with Ruth's interest in higher mathematics.

From his joining the American Society of Agricultural Engineers in 1920, he has been notable in consistent contributions to its technical meetings and to its technical Journal. In 1944-46, he was successively vice-chairman and chairman of the North Atlantic Section. In 1945-47, he served a similar sequence with the Power and Machinery Division, and for some years has been a member of its steering committee.

Other of Professor Clyde's memberships include Tau Beta Pi, Sigma Xi, Phi Kappa Phi, Delta Theta Sigma, Delta Sigma Rho, and the American Society for Engineering Education. He belongs to the Methodist Church, the Masonic Order, and is a registered professional engineer in the state of Pennsylvania. In the latter connection he has assisted the state registration board in preparing examinations.

Except for making graphical or statistical records of baseball and football games, Art Clyde is a perfectly normal human being. He dabbles in amateur magic, dotes on old cars without buying them, acts as sidewalk superintendent on campus and community construction, is a devotee of "do it yourself," and with his wife sang in the church choir for many years.

First Max Eyth Medal Award in America

RAYMOND OLNEY, who has served as editor and publisher of AGRICULTURAL ENGINEERING, the journal of the American Society of Agricultural Engineers, since 1921, was awarded the 1956 Max Eyth Medal by the Max Eyth Society for the Advancement of Agricultural Engineering. Presentation of the medal was made on the occasion of the 49th Annual Dinner of ASAE at the Hotel Roanoke, Roanoke, Va., on June 19. H. Albrecht Sack, a member of the Max Eyth Society and a young German agricultural engineer employed at the John Deere Waterloo Tractor Works, made the presentation.

Raymond Olney *(Left)* receives German agricultural engineering society award from H. Albrecht Sack during ASAE Annual Dinner at Hotel Roanoke, June 19

The Max Eyth Society, the society of German agricultural engineers, named Mr. Olney as recipient of the award in memory of the 120th birthday (May 6) of the German engineer-poet and first agricultural engineer, Max von Eyth. The citation on the certificate aptly describes why an American engineer was chosen; it reads: "The Max Eyth Society for Advancement of Agricultural Engineering awards, with this certificate, the Max Eyth Medal to Mr. Raymond Olney, St. Joseph, Michigan, USA, in deep appreciation of his work in editing scientific publications and his outstanding efforts toward promoting better understanding and relations between American and European Agricultural Engineers."

A congratulatory letter to Mr. Olney from Fritz Muller, chairman of the board of directors of Max Eyth Society, also conveyed a most cordial message, in part as follows:

"We want to express our deepest gratitude for the kind assistance and advice which you have given to so many scientists, university faculty members, and students touring the United States.

"A large number of European agricultural engineers are indebted to you and to the members of the ASAE for the success of their trips through the United States.

"Also, through your work as editor of the Journal of the American Society of Agricultural Engineers you have contributed to a better public understanding of the importance of agricultural engineering and appreciation of the work of agricultural engineers."

Following is Mr. Olney's response in accepting the award:

"To be named a recipient of the Max Eyth Medal is a signal honor indeed—one that makes me very proud, but also very humble.

"The citation for this award expresses appreciation for efforts to promote better understanding and relations between European and American agricultural engineers. A readiness to share the benefits of their professional progress with colleagues overseas has ever been characteristic of our American group, and in my contacts with agricultural engineers of Germany and other countries, I have simply endeavored to exemplify that attitude. So, I like to feel that, in awarding this medal to me as an individual, the Max Eyth Society is, in the larger sense, honoring all of you—you of ASAE—for your generous sharing with colleagues in Europe and elsewhere around the world.

"And now, as a special word to the Max Eyth Gesellschaft, of which I am proud to be a member, I want to say 'Thank you,' as sincerely and as gratefully as I can, for the fine tribute and the great honor conferred upon me."

The Max Eyth Gesellschaft was named in honor of Max von Eyth, who was born in Germany in 1836. In 1861 he traveled to England and entered Fowler's Agricultural Implement Works at Leeds as an engineer. From 1863 to 1866 he served his company in Egypt as chief engineer where he introduced the steam plow. Introduction of the steam plow in Egypt was prompted primarily because of the high cost of cotton grown in the United States during the War Between the States.

Max Eyth was both an engineer and poet, blessed with a fantastic ability to express his thoughts in poetry, even those concerning engineering. He once wrote that he was fortunate to be living in a world that is not living in the past, but in a world of will be.

In 1882, after he returned to Germany, he formed the German Agricultural Society for the purpose of promoting agricultural exhibits, shows, fairs and technical meetings. The Max Eyth Society for the advancement of engineering in agriculture was formed later in his memory. Its present membership is well over 500 members. The organization holds an annual winter technical meeting and a summer meeting held in conjunction with a fair of the German Agricultural Society.

The activities of the society are intended to be of interest to everyone who is concerned with agricultural engineering. The society's meetings provide an opportunity for the presentation of papers, scientific sessions, and personal contact with agricultural engineers from all over the world. The society conducts an employment service, a public information service and an active student member program. Scholarships from industry are available through the society.

Awarding of the Max Eyth Medal was begun in 1950 when Mr. Schlabach, first president of the agricultural engineering council, was awarded the medal posthumously. Other recipients that year included Hermann Raussendorf for his outstanding work in the development of a low-density straw baler and tubular construction of farm machinery, Anton Lentz for development work in the manufacture of the Bulldog tractors, and Erich Reuter for development of a multipurpose cultivator.

Kurt Burchard for his work on an integral hitch for mounting a full line of implements on tractors, and Willy Schosnig for development of a Diesel engine for a small agricultural tractor were awarded the medal in 1951. In 1952 Heinrich Clausing for development work in tillage machinery and Gregor Wolf for his work on the development of hand and garden tools received the medal. The 1953 recipients were Dr. Hans Sack for development of a mechanical sugar beet and potato harvester and Dr. Hans Sack (member ASAE) for development of a sugar beet and potato harvester and Dr. Hans Zodler for development of mounted tractor implements. In 1954 Joseph Eicher for development of an air-cooled Diesel tractor engine and Harald A. Moberg (member ASAE), Swedish Agricultural Machinery Testing Institute, Uppsala, for work in establishing international testing methods for tractors and farm machinery, were awarded the medal. Dr. Walter Mertens for work on development of mowing devices for lodged grains and Friedrich Segler, Sr., for development and design of a forage chopper, were recipients in 1955.

In addition to Raymond Olney, the medal was awarded in 1956 to Dr. Baron of Wilmowsky for his work in coordinating agriculture and industry and to Paul Rober for development of steel seed cleaning machines and introduction of their cooperative use.

The 1956 Max Eyth Medal was presented in honor of the 120th birthday (May 6) of Max Eyth, German engineer-poet and first agricultural engineer who introduced the steam plow into Egypt for the production of cotton during the 1860's

NEWS SECTION

Leonard J. Fletcher Elected Honorary Member

IN recognition of his exceptionally active career, so much of it in behalf of agricultural engineering, and because he always has been bigger than his job, always able and willing to do more than his share, the Council of ASAE recently has elected Leonard J. Fletcher to the grade of Honorary Member in the Society.

LEONARD J. FLETCHER

The election closely followed the announcement of Mr. Fletcher's retirement as vice-president of Caterpillar Tractor Co., after nearly 30 years with the company when he reached the retirement age of 65 on May 1.

Mr. Fletcher was born May 1, 1891, on a dairy farm near Chadron, Nebr. He received a B.S. degree in agricultural engineering in 1915 from Iowa State College. After graduation he remained a few months working on creation of a self-supporting clay block arch for fire-proof barns. He taught agricultural engineering at Washington State College for one year and later was an instructor and head of the division of agricultural engineering at the University of California. In 1927 he entered the employ of the Caterpillar Tractor Co.

In 1929 he began a three-year period in Soviet Russia where he worked with other planning agencies and engineers in the application of mechanical power to grain production and road building. He returned to the United States in 1933. His activities within the Caterpillar organization included director of agricultural sales, assistant general sales manager, director of training, director of community relations division and vice-president of the company.

He became a member of the American Society of Agricultural Engineers in 1918 and has been consistently active. He was chairman of the College Division in 1926-27, chairman of the Power and Machinery Division in 1928-29, and president of the Society in 1931-32. He was awarded the Cyrus McCormick Medal in 1944 and won a University of Missouri medal for distinguished service in engineering in 1954.

Future plans include building a new home in Carmel, Calif., where he and his wife will take up residence.

Stages A-E Field Day

THE Alabama Student Branch of ASAE held its first Agricultural Engineering Field Day on April 13 and 14, for the purpose of publicizing agricultural engineering, and to promote a stronger demand for agricultural engineers. The event consisted of a full day of displays and demonstrations designed to present to the public the latest agricultural engineering developments as they apply to agriculture.

Each division of agricultural engineering was represented by effective displays. Much of the equipment for the displays was furnished by manufacturers and dealers in the area.

In the farm machinery exhibit, many kinds and types of tractors, combines, cotton pickers, mowers, forage harvesters, grain drills, and tillage equipment were on display. A full-size irrigation system, which was put into operation at regular intervals throughout the day on the front lawn of the agricultural engineering building, was the main attraction of the soil and water exhibit.

The rural electrification exhibit included several types and sizes of electric motors, water system displays (including TVA's latest display trailer unit of cutaway water systems), display panels of the latest farmstead wiring systems, and a demonstration model of a refrigeration unit. The main attraction of the electrical exhibit was one of International Harvester Co's Electrall units which was used to power an electric range. In the farm structures exhibit, there were several scale models of pole-frame buildings and a large display of the latest commercial building materials for both interior and exterior use.

The tremendous interest shown by the visitors of the first Alabama Agricultural Engineering Field Day, has impressed the student branch at API that the event was worthwhile in achieving its purpose.

ASAE Meetings Calendar

August 28-30—NORTH ATLANTIC SECTION, Riley-Robb Hall, Cornell University, Ithaca, N. Y.

October 24-26 — PACIFIC NORTHWEST SECTION, Penticton, British Columbia

December 9 to 12 — WINTER MEETING, Edgewater Beach Hotel, Chicago

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

EJC Professional Standards and Employment Conditions Report

THE Engineers Joint Council has released a report entitled Professional Standards and Employment Conditions. In a statement accompanying the report, Thomas H. Chilton, president of EJC, says:

"The report represents the labors of many thoughtful people who have considered and discussed the problems of engineers as employees. A wide diversity of views was to be expected on problems having as many ramifications as these have. The report was finally adopted only after review by the EJC executive committee and special task committee following months of arduous work by EJC's committee on employment conditions.

"It is, therefore, not the work or view of any one individual, and perhaps everyone will find some part of it with which he does not fully agree. It does, nevertheless, represent, I believe, a significant appraisal of employment factors which deserve attention. The EJC board of directors endorses the recommendations contained in this report and strongly urges the constituent societies to examine this entire study carefully.

"Important responsibilities of the professional engineer, employers of engineers, engineering societies, and engineering educators are identified in the report. Each of us as professional engineers, and all others directly or indirectly associated with the profession, must strive diligently to establish a clear understanding of employment conditions necessary to meet professional employee expectations. An employment environment which encourages full professional and technical development of employed engineers is essential to the advancement of the profession, and the realization of their fullest contribution to the economy."

Copies of the report are available without charge from Engineers Joint Council, 29 West 39 St., New York 18, N. Y.

Three Receive USDA Superior Service Awards

THREE extension agricultural engineers were presented Superior Service Awards by the Secretary of Agriculture, Ezra T. Benson, at an honor awards ceremony in Washington, D. C. on June 5.

Virgil Overholt, Fellow of ASAE, received the award "for his contribution to the present effective soil and water management program in the State of Ohio."

Mr. Overholt received a B. S. degree in agriculture at Ohio State University in 1915 and was appointed extension agricultural engineer in Ohio that same year. With exception of service in World War I and time out for advanced work at Wisconsin and Ohio, he spent 41 years as extension agricultural engineer.

Earl G. Welch, member ASAE since 1918, was honored "for leadership in developing needed agricultural engineering practices for Kentucky, and in getting these practices accepted and applied by the farmers of the state."

Mr. Welch received a B.S. degree in agricultural engineering at Iowa State College in 1914 and immediately joined the agricultural engineering teaching staff at the University of Georgia, doing extension work during the summer. In 1920 he was appointed extension agricultural engineer in Kentucky where he has served for the last 36 years.

Ivan D. Wood, Past-President and Fellow of ASAE, was selected to receive the award "for establishing an effective educational program linking farmers, research workers, agency representatives, and commercial people in a friendly cooperative effort to conserve and wisely use irrigation water."

Mr. Wood received a B.S. degree in engineering in 1912 and an M.S. degree in agricultural engineering in 1913 from the University of Nebraska. He was appointed extension agricultural engineer in Nebraska in 1914 serving in that capacity until 1940 with the exception of service in World War I and two special assignments on irrigation and water conservation with the U.S. Forest Service.

In 1940 he became district and area engineer in the 17 western states for the Farm Security Administration. In 1945 he was appointed irrigation engineer with Soil Conservation Service and federal extension irrigation specialist with headquarters in Denver, Colo. He was elected president of ASAE in 1952 and received the John Deere Gold Medal that same year. In 1954 he was the recipient of the honorary degree of doctor of agriculture from the University of Nebraska.

High Lights of the 1956 ASAE Annual Meeting

SOUTHERN hospitality prevailed and a spirit of confidence in reaching the goal of 5000 members by the 50th anniversary year of the American Society of Agricultural Engineers was in evidence at the Society's 49th annual meeting at Hotel Roanoke, Roanoke, Va., June 17-21. Fuel was added to the emphasis on membership progress when figures were released indicating that the Society is only 294 short of the 5000 mark, as of June 1, and that a gain in membership during the preceding year was 288.

In true tradition of the South, the local arrangements group and members of the Virginia Section went all out in arranging and handling the affairs of the meeting. The excellent manner in which all functions were carried out on schedule was in itself a tribute to the fine work done by those in charge.

Activities began on Saturday, June 16, with the Council of ASAE opening its meeting at 2:00 p.m. Other early arrivals were busy setting up extension exhibits and the local committee was making final arrangements for registration.

The registration desk was a beehive of activity on Sunday, and by evening nearly 800, including women and children, were on hand to attend the hospitality supper sponsored by the Virginia Section and a host of companies and associations located or represented in Virginia. Entertainment during the meal was provided by Sammye Stanley Bowman, organist, who played songs of the states, U. F. Earp, chairman of the accommodations committee, presided during the evening program. Members of the local committee were introduced by J. L. Calhoun, chairman of the local arrangements group. An excellent talent program, presented by 4-H members which featured singing, dancing, other musical selections, pantomine and ventriloquism, was enjoyed by everyone. J. A. Waller kept interest high by conducting a raffle at various times during the program. Prizes consisted of ten Smithfield hams and many other foodstuffs produced in Virginia. Bearers of five lucky Confederate bills were also presented with Smithfield hams.

The cabinet meeting was held Sunday at 3:00 p.m. R. J. Alpers, chairman of the Michigan Section, reported on the plans for the Golden Anniversary meeting of the Society to be held in June, 1957, at Michigan State University, East Lansing, Mich. E. W. Tanquary reported on a reorganization plan for the Motion Picture Committee in which a visual aids committee will be formed, and three new subcommittees to be known as the operating, finance, and shooting committees. T. W. Edminster reported on cooperative activity between the ASAE Soil Compaction Committee and the Soil Science Society of America in establishing a classification for soils under compaction and a tentative standard for publication.

T. E. Hienton reported on activities of the ASAE Committee on Engineers' Classification in Civilian and Military Service. He stated that in the latest list of critical occupations, agricultural engineers were listed under the heading of mechanical engineers. He was confident that a new MOS military classification number for agricultural engineers would be adopted soon. T. W. Edminster reported on the addition of an extra day to the Soil and Water Division program for a special session on problems of interest to public lands and public works projects. He said that plans are being made for a similar session at the annual meeting again next year.

A roll call showed a large proportion of Sections represented. In line with increased membership, Section representatives were asked to explain unusual methods used for membership promotion.

Monday forenoon concurrent programs for each of the four technical divisions, the Education and Research Division, and the student group were in session. Organized tours to such scenic and historic places as the VPI campus, Natural Bridge, Lexington, Blue Ridge Parkway Skyline Drive, N. & W. Railway shops, and several manufacturing concerns in the area, were conducted Monday afternoon. During the VPI campus tour, the agricultural engineering building was officially named Seitz Hall after C. E. Seitz, former head of the agricultural engineering department. A dance was held in the Hotel Roanoke starting at 10:00 p.m. on Monday.

Early Tuesday morning various committee meetings were held beginning with a breakfast meeting of extension agricultural engineers, and followed with the meetings of committees on soil compaction, instrumentation and controls, and extension. Several division steering committee meetings were also held Tuesday morning. The regular session of the four technical divisions reconvened at 10:00 a.m.

E. T. Swink, head, agricultural engineering department, VPI, called the general program to order at 1:30 p.m. Tuesday. A. W. Farrall, head, agricultural engineering department, Michigan State University, extended a special invitation from the Michigan Section and MSU staff to attend the ASAE Golden Anniversary Meeting on the MSU campus in 1957.

In the president's annual address, Wayne H. Worthington reviewed the activities of the Society during the year. He warned of impending dangers to the engineering profession and expressed confidence that the Society would meet the challenge successfully.

Winner of the student paper award, Daniel A. VanDuyne, Pennsylvania State University Student Branch, presented his winning paper. His subject was "Automatic Feed Processing From Penn State".

R. H. Driftmier served as master of ceremonies at the ASAE Annual Dinner Tuesday evening. Presentation of awards was made by Wayne H. Worthington. Martin Ronning, chief consulting engineer, Minneapolis-Moline Co., and Harris P. Smith, professor of agricultural engineering, A. & M. College of Texas, each received the Cyrus Hall McCormick Medal. Arthur W. Clyde, professor of agricultural engineering, Pennsylvania State University, received the John Deere Medal. In an excellent address Walter G. Barlow, vice-president of Opinion Research Corp., Princeton, N. J., presented an analysis of agricultural engineering based on an impartial survey. The inauguration of the new president, Roy Bainer, completed the program.

In a special ceremony during the dinner meeting, Raymond Olney was awarded the Max Eyth Medal by the Max Eyth Gesellschaft, the society of German agricultural engineers. Presentation was made by H. Albrecht Sack, a member of the Max Eyth Society and a young German agricultural engineer employed at the John Deere Waterlo Tractor Works. Mr. Olney is the first American to receive the award.

Authors and titles in the Journal Paper Award list were C. F. Kelly, T. E. Bond and N. R. Ittner, "Water Cooling for Livestock in Hot Climates;" H. D. Bruhn, "Status of Hay Crusher Development;" Jack T. Gunn and V. N. Tramontini, "Oscillation of Tillage Implements;" James S. Boyd and Henry Giese, "Secondary Stresses in Glued Trusses;" Vernon H. Baker, Dennis E. Wiant and Oscar Taboada, "Effects

(Continued on page 498)

The J. B. Davidsons Honored

Prior to leaving Ames, Iowa, for their new home in Denver, Dr. and Mrs. J. B. Davidson were honored in a surprise tribute by the Agricultural Engineering Wives' Club on April 25, at the Ames Congregational Church. The program patterned after a television show, was entitled "This Is Your Life, Jennie Davidson," and portrayed, by narration, pantomine, pictures and music, the life of Mrs. Davidson. In the illustration Mrs. Henry Giese *(left)* is shown presenting Mrs. Davidson with a package of some fifty letters from friends who were not able to attend. Mrs. Benton M. Stahl *(right)* served as narrator. Standing is Dr. J. Brownlee Davidson, first president of ASAE and for many years head of the agricultural engineering department at Iowa State College.

ASAE MEMBERS in the News

H. F. MILLER, JR.

WILLIAM BOSS

Herbert F. Miller, Jr., has been appointed as head of the farm machinery section Agricultural Research Branch, U. S. Department of Agriculture, Beltsville, Md.

Mr. Miller attended John Tarleton Agricultural College and Texas A & M College, receiving a B.S. degree in agricultural engineering from the latter in 1942, and an M.S. degree in 1948. He spent five years in the U. S. Army, two of which were in Europe. The fifth year was at the Aberdeen Proving Ground, six months as proof officer testing tires and tracks. He now holds the rank of Major in the U. S. Army Reserves.

From 1948 to 1952, Mr. Miller was engaged in agricultural engineering research at the Texas Agricultural Experiment Station, College Station. In April, 1952, he joined the USDA Agricultural Engineering Research Branch and was assigned to cotton production and harvesting machinery research at Shafter, Calif. He was transferred to Beltsville in June, 1954, as acting head of the Farm Machinery Section, in which capacity he has continued to date.

■

William Boss, charter member, life fellow, and past-president of ASAE, received an honorary degree of doctor of science at Jamestown College, Jamestown, N. D., on June 4.

In addition to the title he holds as professor emeritus of agricultural engineering, University of Minnesota, where he taught and served as chief of division of agricultural engineering for many years, he serves as chairman of the board of directors of the Specialty Mfg. Co., an establishment he developed as a young man, and is president of The Boss Foundry.

Mr. Boss was born on a farm near Zumbro Falls, Minn., on October 7, 1869. Although he had no formal education in agricultural engineering, he was one of the founders of the profession, a pioneer among creators of curriculums for its teaching, and designer of the first major building for its housing. In 1902 he became head of the Specialty Mfg. Co. of St. Paul, which he had organized. He has many patented inventions and is accredited with many developments in planting and harvesting machinery and other machines closely related to agriculture.

In 1905 he became half-time professor and chief of the division of farm structures and farm mechanics, forerunner of agricultural engineering, at the University of Minnesota. In 1909 he left the University to devote full time to his business, but in 1918 he returned to half-time with the University and within a year full-time. In 1938 Mr. Boss attained the official retirement age at the University of Minnesota and retired as emeritus professor of agricultural engineering.

He was elected president of ASAE 20 years after the founding of the Society of which he is a charter member. He was a recipient of the John Deere Medal in 1943.

●

Glenn I. Johnson, extension agricultural engineer, University of Georgia, has been awarded a fellowship for advanced study and will attend summer school at Cornell University, Ithaca, N. Y.

●

David F. Goyer, has been transferred from retail training to the position of commodity technical man, Cooperative Grange League Federation Exchange, Inc. In his new position he will engage in training of retail personnel and field problems along with quality control. His new address is Two 4th St., Oneida Castle, N. Y.

■

Paul R. Hoff has returned from an assignment with the College of Agriculture, University of the Philippines, for the past two years on an ICA contract with Cornell University, Ithaca, N. Y. He will resume his duties with the department of agricultural engineering at Cornell.

●

Fred C. Fenton, past-president and Fellow of ASAE, has announced his retirement as head of the agricultural engineering department, Kansas State College, and has accepted a two-year assignment with the International Cooperation Administration to advise the government of India on their agricultural engineering program.

Mr. Fenton, accompanied by his wife, reported to Washington, D. C. in June for an orientation program, and expects to fly to India early in July. He will be stationed at New Delhi.

Among things on which he is expected to advise are improvement of professional training of agricultural engineers in India's technical schools, improvement of irrigation techniques, introduction of farm machinery, improvement of land reclamation, and improvement of grain storage.

Mr. Fenton has done special research in grain storage, rural electrification, farm structures, and wind pressures. He has served as head of the Kansas State agricultural engineering department since 1928.

■

H. H. DeLong has resigned as head of the agricultural engineering department, South Dakota State College, to devote full time to teaching and research. He will continue as professor of engineering, teaching farm power and machinery and rural electric courses, and conducting research in crop processing.

Mr. DeLong received a certificate recently in recognition of his 27 years of service at State College. He joined the staff in 1930 as a district 4-H leader. In 1935 he joined the agricultural engineering faculty, becoming acting head of the department in 1945 and head in 1948.

■

Dennis L. Moe, associate professor of agricultural engineering and research agricultural engineer, has been named as head of the agricultural engineering department, South Dakota State College. He was graduated from South Dakota State College and holds B.S. and M.S. degrees in agricultural engineering. He is widely known for his work in developing a lightweight aggregate for concrete construction from shale.

●

Frederick P. Stephan, formerly research associate, agricultural engineering department, Iowa State College, is now project engineer with the James Mfg. Co., Fort Atkinson, Wis.

●

H. C. Steury has accepted a position in the general engineering office of the Caterpillar Tractor Co. at Peoria, Ill. He had previously been employed as a design engineer with the J. I. Case Co. at Burlington, Iowa.

■

William R. Smith, has accepted a position as design engineer with the Tractor and Implement Div., Ford Motor Co. He was formerly employed by the Cockshutt Farm Equipment, Inc., Brantford, Ontario.

●

Hindrik M. Elema has returned to the Institute of Agricultural Engineering and Rationalisation, Wageningen, Netherlands, after assisting in establishing the power and machinery division of the Department of Agricultural Engineering at the Israel Institute of Technology, Haifa, Israel

■

D. P. Blight has left the department of agricultural engineering at King's College, Newcastle-upon-Tyne, where he was research assistant while studying for his Ph.D. degree, and is now scientific officer at the National Institute of Agricultural Engineering, Scottish State, Howden, Mid Calder, Midlothian, Scotland.

●

Charles D. Murray, formerly product test engineer for International Harvester Co., Davenport, Iowa, has accepted the position of test laboratory supervisor at the Cherry-Burrell Corp., Cedar Rapids, Iowa.

●

D. Glenn Rodeheaver, formerly with the New Holland Machine Div. of Sperry Rand Corp., has accepted a position as research assistant in Rocket Design Group, Hercules Powder Co., Cumberland, Md.

●

Jack L. Sparks has resigned from the technical staff of the University of Maryland and his assignment in Georgetown, British Guiana, to accept a position with the International Development Service, Inc., in Guatemala, where he will be working as an irrigation engineer.

●

P. C. Mortenson, formerly administrative engineer, western hemisphere, Massey-Harris-Ferguson, Inc., has accepted the position of chief engineer with Vickers, Inc., Detroit, Michigan.

■

Carl T. Young has resigned from Starline, Inc., Albany, N. Y. to accept a position as agricultural engineer with the James Mfg. Co., Fort Atkinson, Wis.

■

Wyn E. McCoy has been promoted from district manager of the Chicago office of Timken Roller Bearing Co. to sales promotion manager at the Canton, Ohio, office.

■

Daniel A. Kitchen has resigned his position with the National Safety Council to accept a position with the Aubrey, Finlay, Marley & Hodgson advertising agency.

●

Donald G. Smith has left the employ of the Hester Plow Co., Inc., Jacksonville, Fla., to become design engineer for the Moore Dry Kiln Co. in Jacksonville.

●

Philip L. Benfield, formerly with the Biological Sciences Branch, (AMS), USDA, Plant Industry Station, Beltsville, Md., has accepted the position of representative for the Douglas Fir Plywood Assn., Charlotte, North Carolina.

●

Howard W. Miller, Jr., has resigned as farm technical advisor of the Pennsylvania Power and Light Co. to join the Soil Conservation Service as an engineer trainee with the Wyoming County work unit, Tunkhannock, Pa.

(Continued on page 498)

There's a GOLD MINE in the Sky

THE air over a single acre of land carries about 35,000 tons of gaseous nitrogen. If all this nitrogen could be transformed into a fixed form such as ammonium nitrate, it would have a value of over $5,000,000 as commercial fertilizer.

The key that unlocks this untold wealth is legumes. When properly inoculated, limed, and fertilized, legumes can take nitrogen from the air and change it into usable fertilizer. True, they need some of this plant food for their own growth; however, a good share of it is stored in nodules on their roots for the use of crops that follow.

Legumes, storing up nitrogen and producing an abundance of organic matter, are a tonic for all other crops in the rotation, yet they more than pay their way. A season's growth of good alfalfa, for instance, not only produces a profitable crop but will fix from $10 to $20 worth of nitrogen per acre.

Another part of this story is that modern farm equipment is designed to help farmers work this "gold mine in the sky." Ask any John Deere dealer for more information on this equipment.

JOHN DEERE
MOLINE, ILLINOIS
Quality Farm Equipment Since 1837

ASAE MEMBERS in the News

(Continued from page 496)

Jerles E. Russell, agricultural engineer, Soil Conservation Service, USDA, at Huntsville, Ark., has been assigned to the SCS watershed project in Arkansas, with headquarters at Little Rock.

•

Harry M. Meinert was recently discharged from military service and has accepted a position in the engineering department of the John Deere Planter Works, Moline, Ill.

•

Calvin J. Baxter has been released from the U.S. Air Force and is now employed as a detailer by the Geneva Steel Company.

•

David B. Puryear, graduate fellow in agricultural engineering, Purdue University, has accepted a position with the Bendix Aviation Corp., St. Joseph, Mich.

•

Abraham S. Fenster has been transferred from advanced designer, advanced engineering department, to assistant product engineer at the McCormick Works of the International Harvester Co.

•

Kenneth E. VanLiew has accepted a position as maintenance and service intructor with the Cummins Engine Co., Columbus, Ind. He was formerly on duty with the U.S. Air Force.

•

A. R. Hunsicker, production control manager of the New Holland Machine Div., New Holland, Pa., has been transferred to the company's subsidiary in Dandenong, Victoria, Australia.

NEW BOOKS

Heating, Ventilating, Air-Conditioning Guide, 1956 (34th edition) by American Society of Heating and Air-Conditioning Engineers, Inc., 62 Worth St., New York 13, N. Y. Cloth, 1176 pages, 6 x 9 inches, illustrated and indexed. $12.00.

The new edition contains 53 chapters, of which 16 have been improved and some almost completely rewritten. Most significant changes were made in the subjects dealing with heat transmission of building materials, cooling load, chimneys, estimating fuel consumption, baseboard and finned-tube radiation, snow melting, central systems for air conditioning, air-duct design, air heating and cooling coils, automatic control, pipe and tube characteristics and insulation, automobile air conditioning, heat transfer measurements, and codes and standards.

A Treatise on Surveying (Sixth Edition) Two volumes by Middleton and Chadwick. Edited by W. Fisher Cassie. Cloth, 6 x 9 inches, Volume I, xiii+381 pages. Volume II, xi+438 pages. Illustrated and indexed. Philosophical Library, Inc., 15 East 40th St., New York 16, N. Y. $20.00 per set.

This two volume work has been revised by having each chapter undertaken by a prominent expert in its particular field. Much of the work has been recast and rewritten. Special attention has been paid to the most recent developments in surveying technique, such as those of echo sounding in hydrographic work and the accurate location of aircraft in air survey. Volume I deals with instruments and basic techniques. Volume II covers the more advanced techniques and modern developments.

Farm Electrification by Robert H. Brown. Cloth, viii+367 pages, 6 x 9 inches. Illustrated and indexed. McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y. $7.00.

This book is written for the student who has had no prior training in electricity and wishes to acquire a good general knowledge of the subject, and for the non-agricultural engineering major who will have only one course in farm electrification.

Instead of emphasizing theory, this book stresses applications, safety features, procedures for selecting equipment and supplies, planning and installing wiring systems, modifications, and the practical utilization of electricity. The subject matter is divided into two major areas: preparation for the use of electricity, and using electricity for productive farm jobs.

NECROLOGY

Bernard L. (Ben) Hagglund, Southwest sales manager of Caterpillar Tractor Co., and a resident of San Leandro, Calif., died May 12, after a short illness. He has been associated with Caterpillar since 1930.

BERNARD L. HAGGLUND

A native of Iowa, Mr. Hagglund was born June 23, 1895, at Essex. He spent his boyhood on an Iowa farm, attended grade and high school and was graduated from Iowa State College with a B.S. degree in agriculture in 1918.

He served with the U.S. Army coast artillery during World War I, largely on the Island of Corregidor and at other Philippine points prior to his discharge in 1919. Later he returned to Iowa State as an instructor for a year and then moved to the University of California where he was a county farm advisor at Modesto until 1928. The following two years, he was ranch manager for the Atascadero Development Syndicate.

Mr. Hagglund joined Caterpillar in 1930 as a supervisor in agricultural sales, became a special representative in 1932, district representative in 1934, and an assistant sales manager for the western division in 1940. He was named sales manager in 1944. During his 26 years with the company, he played a large part in setting up and continuing the development of the company's dealer program in California and the western division. He has been recognized as an outstanding student of agricultural trends and was considered an authority on agriculture on the West Coast.

Mr. Hagglund has been active in youth activities particularly the Boy Scouts of America, the Future Farmers of America, and the 4-H. He was a past-president of the Tractor and Implement Club of Oakland, a member of the Commonwealth Club of San Francisco, and recently was chairman of the Pacific Coast Section of the American Society of Agricultural Engineers.

Mr. Hagglund is survived by his wife, Eleanore, also a native of Iowa, and three children.

•

A. M. Goodman, 71, of Ithaca, N. Y., died suddenly while at work on a private surveying job, May 29.

He was professor emeritus of agricultural engineering at Cornell University, having retired on July 31, 1952, after serving 33 years. He was graduated from Cornell in February, 1912, with a B.S. degree in agriculture. Following his retirement in 1952 he served two years with the Cornell staff at the college of agriculture at Los Banos in the Philippines.

Mr. Goodman has been a member of the American Society of Agricultural Engineers since 1927. He was a member of Epsilon Sigma Phi, Sigma Xi, and New York Society of Professional Engineers.

He is survived by his wife, Clara, three daughters and one son.

1956 ASAE Meeting

(Continued from page 495)

of Electromagnetic Energy on Plants and Animals."

Cited as Student Honor Award winners for outstanding scholarship and participation in student activities were Gordon H. Allard, University of Maine; Vernon L. Anderson, State College of Washington; Donald A. Backus, State College of Washington; James W. Board, University of Arkansas; Fred Bouse, Oklahoma A & M College; James E. Bruns, Alabama Polytechnic Institute; David Bucher, Pennsylvania State University; Danny Burgess, Kansas State College; John G. Christopher, Kansas State College; John L. Clingerman, Ohio State University; John Cryder, Ohio State University; Donald Daum, Pennsylvania State University; Irvin A. Eickmeyer, University of Illinois; J. Arvid Forsman, University of Maine; Lawrence H. Gay, Iowa State College; Leland Gilbert, Colorado A & M College; Edwin V. Lance, Oregon State College; Ronald K. Leonard, Iowa State College; Kenneth Matthes, North Carolina State College; Richard J. Morrow, Iowa State College; Milton W. Nitsch, Texas A & M College; Byron H. Nolte, University of Missouri; Dale Owen, University of Wisconsin; John A. Replogle, University of Illinois; Donald Snyder, Pennsylvania State University; Earl A. Terpstra, Michigan State University; William S. Thompson, North Carolina State College; James E. Turner, Jr., Virginia Polytechnic Institute; Paul K. Turnquist, Kansas State College; John C. Williams, Texas A & M College; and Virgil A. Zastrow, University of Missouri.

FEI Trophy Awards were presented at a student luncheon Wednesday noon with the compliments of the Farm Equipment Institute. The Georgia Student Branch was the Group A winner, with honorable mention to the Pennsylvania and Michigan Branches. North Carolina took the Group B trophy, with the Oklahoma and Colorado Branches receiving honorable mention.

Frank P. Hanson, chairman of the FEI Research Committee, presided at the luncheon. D. F. Turner, chairman of the FEI Award Committee, presented the trophies and certificates. William J. Fisher, vice-president, The Oliver Corp., York, Pa., spoke to the group on "The Opportunities Ahead for the Agricultural Engineering Graduate".

All-day technical sessions were conducted on Wednesday. The Power and Machinery Division held a joint meeting with the National Joint Committee on Grassland Farming Wednesday afternoon. The Honorable True D. Morse, Under Secretary of Agriculture, addressed the group on the subject "Soil Banks for More Profits."

The Soil and Water Division extended its program one extra day on Thursday to include problems of special interest in the development and maintenance of military and other grounds connected with public works projects.

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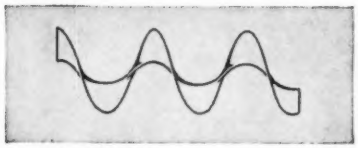

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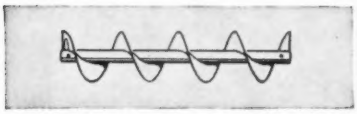

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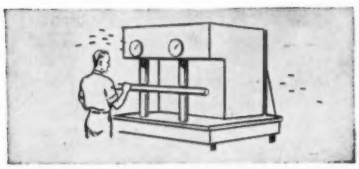

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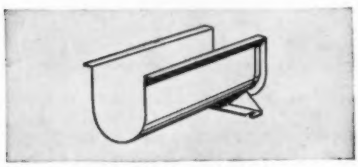

ALL COMPONENTS — conveyor screws, collars, couplings, hangers, troughs, trough ends, flanges, drives —are available for every design.

ENGINEERING SERVICES. Our auger specialists will help you analyze your special needs . . . integrate all elements of your design.

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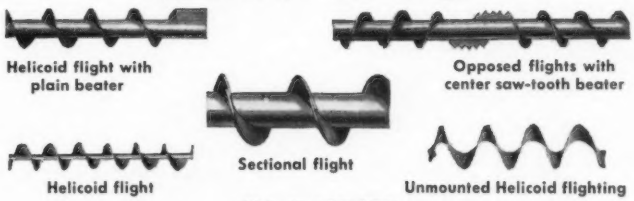

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FARM MACHINE AUGERS

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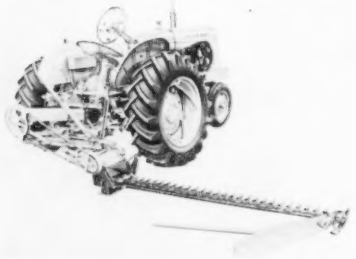
Twin-Wheel Drive Mower

Allis-Chalmers Mfg. Co., Milwaukee, Wis., has developed a new concept in mower design, which uses a twin-wheel drive instead of conventional pitman drive. The new Model 7 is available both in rear-mounted and trail-type models.

Non-stop rotary action of twin flywheels with heavy matching balanced counterweights drives the sickle and is said to elim-



inate practically all vibration because the start-and-stop action of the sickle is counterbalanced and smoothed out.

The new drive is mounted directly on the cutter bar, permitting operation of the sickle at any angle from 90 deg above horizontal to 45 deg below horizontal. The hydraulic ram determines the amount of lift. The sickle is powered through two short connecting rods in the same plane and always level with the sickle regardless of the angle or height of cut. The short stroke of 2½ in at 1400 rpm makes possible up to 2800 cutting strokes a minute.

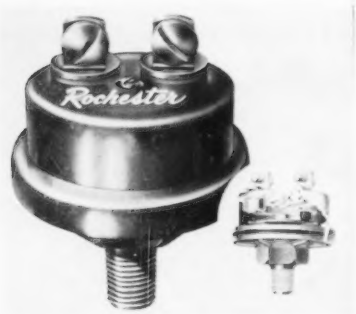
The twin flywheels are designed to balance each other and balance the sickle. Counterweight action is always opposite to the direction of sickle travel.

New Vacuum Switch

Rochester Mfg. Co., Rochester 10, N. Y., has introduced a new heavy-duty-type vacuum switch, designed for a broad field of application.

Housed in a hermetically sealed dustproof steel case, the RMC vacuum switch features a spring-loaded diaphragm, Buna-N-impregnated, against heavy vibration, pulsation and shock.

Operation, which is factory calibrated, opens and closes a contact at fixed vacuum



values. It is available for normal open or normal closed use at zero vacuum with setting up to 22 in. It is used with 6, 12 or 24-volt d-c, but can be modified for low voltage alternating current and is supplied in either single-terminal grounded or double-terminal models.

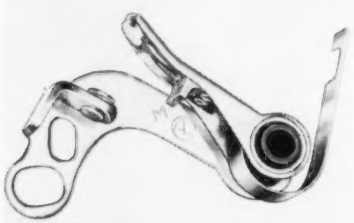
Line connection is made at center of back, ¼ or ⅛-in male pipe thread. Overall measurements are 1¾ in wide and 2 1/16 in top of terminal to end of pipe thread.

NEW PRODUCTS CATALOGS

Low-Speed Distributor Points

The Electric Auto-Lite Co., Toledo 1, Ohio, has announced new special-duty distributor points for farm tractors. The new points are designed for better performance under the rigors of continuous low speed operating conditions.

The new point sets can be used on many makes and models of tractors. They feature big contact surfaces, 78 percent more con-



tact area than standard sets, and have broad-beam, reinforced construction of the movable arm.

Tool Bar Cultivator

International Harvester Co., Chicago 1, Ill., has announced a new tool bar cultivator for the International 300 Utility tractor. The new cultivator handles two rows and carries four gangs positioned along a 2½-in square tool bar that hitches directly to the rear of the tractor. The cultivator can be adjusted to any row spacing from 26 to 42 in by loosening and sliding the gangs along the bar.

A gauge wheel is located at each end of the tool bar for depth control with the equipment riding on the gauge wheels. When the cultivator is raised, gauge wheels and all come off the ground. A guide colter mounted on the tool bar in the center prevents the cultivator from drifting. The colter is held in the ground by spring pressure which permits it to rise out of the ground when hard spots are encountered without raising the cultivator.

Auxiliary Tractor Seat

Caterpillar Tractor Co., Peoria, Ill., has announced a new auxiliary seat attachment for Caterpillar D9 and D8 tractors.

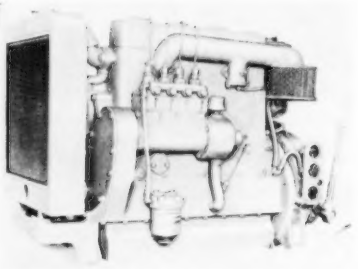
The new auxiliary seat mounts on the deck of the tractor. It has been designed to provide a convenient and safe means of

transportation for a helper or other personnel.

Cushions and backrest of the new seat are padded with foam rubber. It is upholstered in scuff and water-resistant synthetic material. The seat cushion can be easily tipped when the tractor is not in use. It is not adaptable for use on D9 tractors equipped with cabs.

New 42-HP Diesel

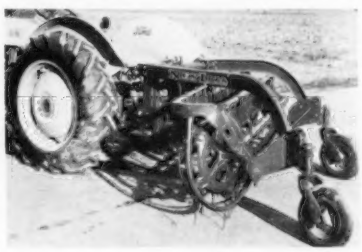
R. H. Sheppard Co., Inc., Hanover, Pa., has announced its new 4-cylinder, Model 19 diesel with 153.6 cu in displacement and rated at 42 gross bhp at 2000 rpm. The most noteworthy feature of this diesel is its compact size. It is intended primarily as replacement power and can be installed without alterations to driven machines. Like



all Sheppard diesels, the new model is a 4-cycle engine that features 22-to-1 compression ratio and the company's own fuel injection system that can be serviced in the field without special tools or equipment. The new model is available as a fan to flywheel engine, as an open power unit, standard power unit or closed power unit. It is also offered as a 10, 12 or 15-kw generating set.

Mounted Rake Fits 29 Tractors

New Idea Farm Equipment Co., Coldwater, Ohio, has announced that its new No. 49 mounted parallel bar rake has been adapted to 29 different tractor models, the



latest additions being the Blackhawk 35 and Minneapolis-Moline 445 Universal. The company reports that it will fit all three types of quick hitches—including 3-point, International Harvester and Allis-Chalmers tractor hitches.

Registered Irrigation

John Bean Division, Food Machinery and Chemical Corp., Lansing 4, Mich., has released a new pamphlet which discusses in detail the advantages of irrigation systems and how registration of each system provides the user with benefits and company service. According to the pamphlet, each installation is numbered and all data relevant to the installation—such as plot of the land, water-supply sources, climatic conditions, and manpower available—is made part of a permanent record kept on file by the manufacturer. Thus information on each system is readily available, should any changes or alterations become necessary. In addition, the registration system permits the manufacturer to help keep the user abreast of all new developments in irrigation processes and equipment. Copies are available by writing to the company and requesting pamphlet W-612.

(Continued on page 502)

FREE!

County agent kit shows how to increase farm profits with Kaiser Aluminum Roofing!

1 FREE "Farm Guide" contains factual information and engineering data on Kaiser Aluminum Roofing and Siding.

2 FREE catalog on 11 building plans developed by Kaiser Aluminum Agricultural Research Service.

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GENERAL PURPOSE BARN
FARM BUILDING PROGRAM
QUALITY MATERIALS + PRACTICAL PLANS = BETTER FARM BUILDINGS

3 FREE sample plan. Most plans feature low-cost, pole-type construction. Complete set of working drawings.

THESE instructions and plans will help you show farmers how to get the most profit from the unmatched properties of Kaiser Aluminum Roofing—lightness with strength, reflection of hot summer sun, retention of warmth in winter, long life without painting or other costly maintenance; no rusting, no rotting, no warping.

Kaiser Aluminum Roofing is available in 26″-wide sheets, or in the new, 48″-wide size that saves 7% to 11% in metal, and greatly speeds installation time. Investigate this quality roofing for better farm buildings!

Help the farmers in your area to bigger profits—send for your free kit now!

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Kaiser Aluminum Roofing and Siding, Roll Valley Flashing, Welded-Clad Irrigation Pipe

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1924 Broadway, Oakland 12, California

Please send a free County Agent Kit to:

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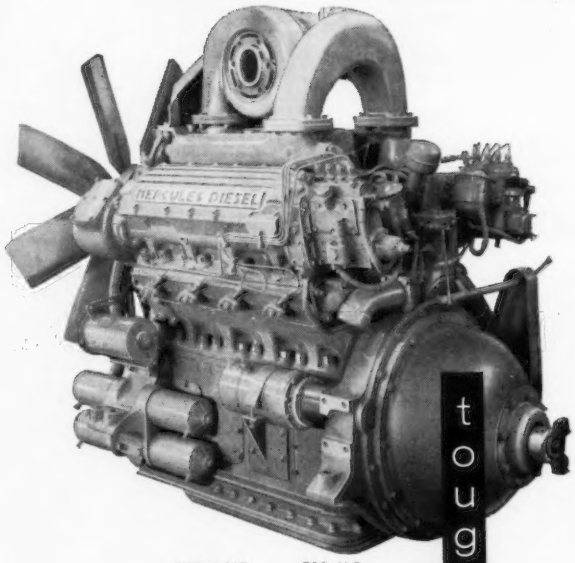
CITY AND STATE_____

THREE MORE HERCULES ENGINES

TCD's



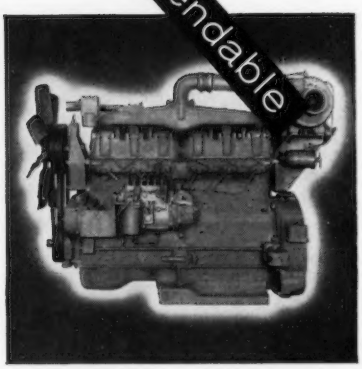
tough

TCD-1468 500 H.P.

compact

dependable

TCD-501 180 H.P.



TCD-895 318 H.P.

Turbo Charged Diesel

Following the Hercules policy of
providing industry with the latest in engine developments,
the above Hercules TCD's are available for applications requiring
Tough Compact Dependable power. Complete details on these TCD's are
available from the factory. Write for Bulletins
D-534, D-561 and D-567.

HERCULES MOTORS CORPORATION
CANTON, OHIO

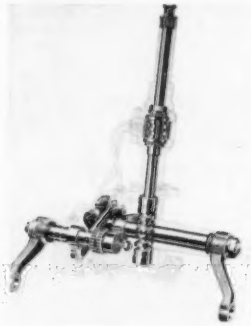
New Products and Catalogs

(Continued from page 500)

Power Steering Unit

International Harvester Co., Chicago, Ill., has announced that power steering is available for the International 300 Utility tractor for factory application and for field installation on tractors already in use.

The new power steering operates off the tractor's hydraulic system. The unit is compact and is built as an integral part of the steering gear within the housing. It is



operative whenever the tractor engine is running. At all times, manual steering is standby reserve in case it is needed.

The power steering unit is of the cam-and-lever type, with a built-in hydraulic valve and cylinder. When the steering wheel is turned, the valve on the steering post directs hydraulic power to the cylinder piston that moves the steering arms on the tractor. After completing a turn, a light pressure to the steering wheel resumes the tractor to straight-line travel.

Corn Harvesting Booklet

Deere & Company, Moline, Ill., has released a new 35-page booklet in color, entitled "Combining, Drying, and Storing of Corn." The text of the book was written by George E. Pickard, professor of agricultural engineering, University of Illinois. Its object is to point out the advantages and some limitations of harvesting corn with a grain combine. It emphasizes the frequent need for drying combined corn and tells much about various drying equipment. The booklet also discusses the advantages of storing shelled corn and offers suggestions on how to convert old corn cribs. The information in this booklet should be helpful to farmers and assist them in evaluating corn combining in terms of their own farm operations. Copies may be obtained by writing to the company.

Forage Farming Booklet

A. O. Smith Corp., Harvestore Division, Kankakee, Ill., has released a new booklet, entitled The Harvestore Farm Profit Plan, which describes a concept of farming referred to as vertical farming.

The plan begins with the land and its best use. It stresses the importance of a well-balanced fertilizer system combined with adequate crop rotations and efficient cropping systems to secure greater production from an acre of land. However, the main part of the booklet deals with the utilization and feeding of the crops and forages by means of the glasslined steel structure, called the Harvestore. The booklet shows how the plan can be used for harvesting, storing and feeding the various forage crops at savings in labor and less crop spoilage.

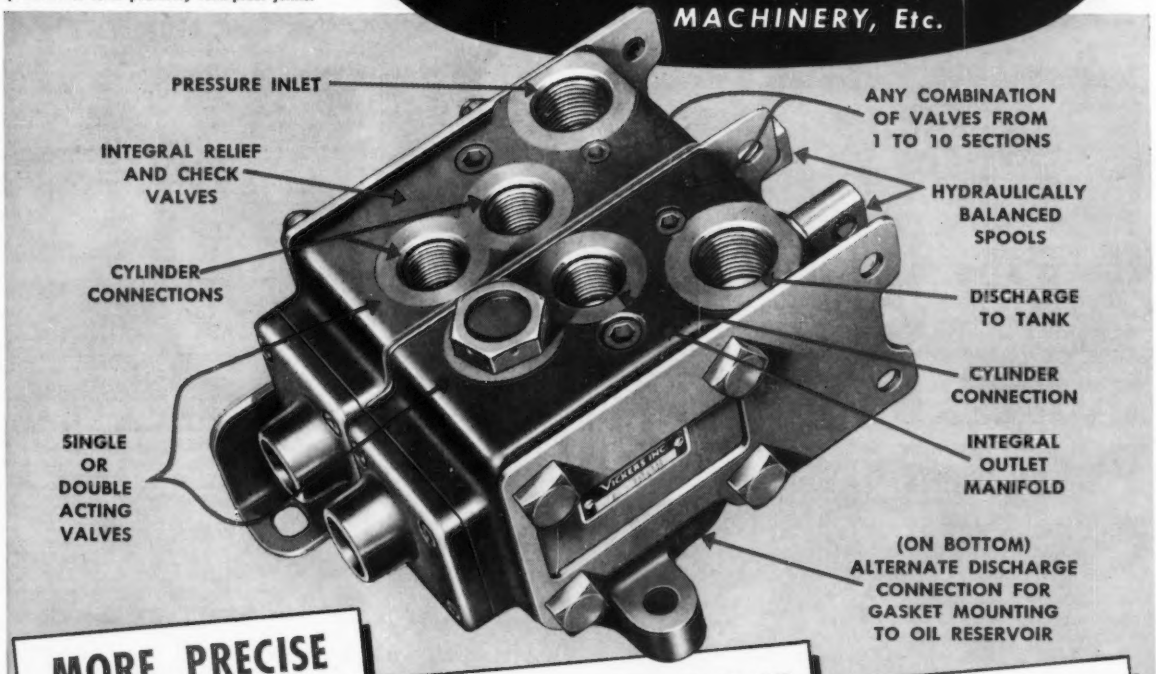
(Continued on page 504)

(Partially exploded view)

"O" ring seals between valve sections seal with pressure to form positively leak-proof joints.

Series CM11 VICKERS® MULTIPLE UNIT VALVES

For MATERIALS HANDLING EQUIPMENT, FARM TRACTORS, BUCKET LOADERS, CONSTRUCTION and MINING MACHINERY, Etc.


PRESSURE INLET
INTEGRAL RELIEF AND CHECK VALVES
CYLINDER CONNECTIONS
SINGLE OR DOUBLE ACTING VALVES
ANY COMBINATION OF VALVES FROM 1 TO 10 SECTIONS
HYDRAULICALLY BALANCED SPOOLS
DISCHARGE TO TANK
CYLINDER CONNECTION
INTEGRAL OUTLET MANIFOLD
(ON BOTTOM) ALTERNATE DISCHARGE CONNECTION FOR GASKET MOUNTING TO OIL RESERVOIR

MORE PRECISE CONTROL

Improved Metering Characteristics

REQUIRES LESS SPACE

New Combination Operating-Valve and End-Plate Sections

LOWER COST

Simplified Design and Construction

This is a more compact and versatile design of valve. End sections combine in one casting the inlet or outlet manifold plate together with any operating-valve section. Inlet section also contains relief valve. Individual outlet plates available for single unit valves. Single- and double-operating valve sections can be added between end sections as needed. Valve can be adapted for tandem (series) operation. Single-acting valves available for either direction of lever shift.

Other features include protection of pump from reverse flow during shifting . . . three point mounting for more simple installation . . . cylinder connections with ¾-16 N.F.-2 straight threads (AND 10050 type) help insure leak-proof connections . . . optional outlet ports in end section so valve can be gasket mounted to the oil reservoir or pipe connected. Designed for use with Vickers Series V-200 Vane Pumps (up to 11 gpm), the CM11 Valve can be used up to 2000 psi working pressure. For further information write for Catalog No. M5101-A.

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7496

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

New Products and Catalogs

(Continued from page 502)

New LP-Gas Tractor

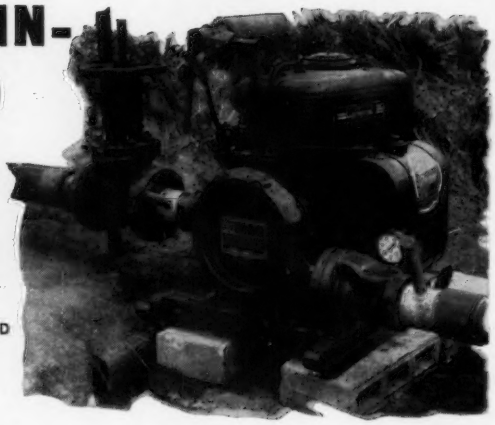
Minneapolis-Moline Co., Minneapolis 1, Minn., has announced the new 445 LP-Gas model tractor. Rated in the 40 hp class, the new model is available in both universal and utility types.

New design, 10-speed Ampli-Torc transmission, power steering, fully hydraulic control of mounted 3-point hitch implements, traction amplifier, and a 9.1 to 1 compression ratio are features of the new tractor.

Fuel capacity is 23.5 gal for the universal type, and 22 gal for the utility, at normal 80 percent level. The safety valve is set at 312.5 lb. Filler valves are located on the left side of the tank for convenience in filling from the ground. Liquid and vapor control valves are of the excess-flow type designed to shut off fuel automatically in case of line breakage.

The LP-Gas passes through a felt and screen filter into an Ensign Model W heat exchanger where the fuel is vaporized. Hot water from the engine circulates through the vaporizer. The heat exchanger controls flow of fuel and fuel pressure by reducing pressure to slightly below atmospheric pressure. It is mounted under the hood in front of the fuel tank.

keep the sprinklers going . . . with a WISCONSIN-POWERED Pumping Unit



Gorman-Rupp Model 53M-TFD centrifugal pumping unit, powered by 2-cylinder Wisconsin Heavy-Duty Air-Cooled Engine.

Supplying a continuous flow of water for a sprinkler irrigation system is work that calls for HEAVY-DUTY ENGINE STAMINA above everything else.

All Wisconsin Heavy-Duty Air-Cooled Engines are of basic *high torque* design . . . engineered and built to "take it" hour after hour, day after day under either constant or variable load operation. These engines have the inbuilt stamina that *hangs on* and keeps the sprinklers going.

Wisconsin Engines, as supplied for irrigation service, are furnished with Stellite-faced Exhaust Valves, solid Stellite Valve Seat Inserts and positive type Valve Rotators . . . increasing valve life from 200% to 500% and reducing valve maintenance service in like measure. Automatic High Temperature Switch provides protection against preventive maintenance negligence . . . shuts off engine before damage can occur.

Basic AIR-COOLED design minimizes the number of parts concerned with cooling . . . reduces weight, which makes for most convenient portability . . . operating from ponds, ditches, streams, lakes or field wells.

All models (3 to 36 hp.) can be supplied with electric starter and generator or starter only, if specified when engine is built. For further information write for folders S-181 and S-188 . . . and specify "WISCONSIN" for your pumping unit.

WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 46, WISCONSIN

Flareless Tube Fitting

The Weatherhead Co., Fort Wayne Division, Fort Wayne, Ind., has designed a new type 7000 series high-pressure SAE flareless, straight-thread hydraulic-tube fitting. This new fitting is an adaptation of a design used extensively in military, construction and industrial equipment for hydraulic and penumatic systems. It is designed to accommodate minimum close

coupling, positive seal and ease of assembly. It also has a new phosphate finish which is said to be resistant to non-flammable hydraulic fluids as well as petroleum base fluids.

Specifically designed for high-pressure systems, the new tube fitting is stocked in 31 different styles and in sizes from ⅛ to 2 inches.

LP-Gas Flame Weeders

Gas Tools, Inc., Subsidiary of Van Horn Butane Service, Fresno, Calif., has announced its new line of LP-Gas flame weeders for controlling annual weeds and grasses. The weeder designed for alfalfa and potatoes (shown) is 18 ft in width and mounted on a 500-gal LP-gas trap wagon. The outer 6 ft on both sides fold in for highway travel. The strawberry burner covers two beds. The cotton weeder is designed for any standard 2 or 4-row tractor. It is driven through the field at a speed of 3 mph which reportedly exposes the plants long enough to kill the weeds but leave the cotton undamaged. Staggered burners are set to sweep the flame across the rows striking the ground at approximately the base of the crop plants.

Early models of the 4-row cotton weeder were equipped with a water-heated vaporizer using the circulation system of the tractor engine. In the new model the water vaporizer has been eliminated and vaporization takes place in the burner head. This simplifies installation and service work and maintains an even rate of vaporization. New burner heads are made of cast bronze.

BURLAP BULLETIN

News about packaging and agricultural and industrial developments in burlap

The Bag Picture at the Hunterdon G.L.F.

"Filling, stitching and tagging, burlap bags have more 'give' and can be dragged around," says Donald Washburn, Manager of the Hunterdon G.L.F., Flemington, N. J. "We like the bag that doesn't have to be handled gently and stacks without slipping.

Our men can work faster loading and unloading with burlap bags that are easy to grab and can be tossed without bursting.

Besides feed, we sell seed in burlap, too. See what a neat, strong package this bag of seed oats makes. No tearing–no spilling.

This is grist that our dairy farmers have brought in which we have ground and mixed with molasses. We're here to serve the farmer and he likes to get his supplies in the bag that's *tough;* and, thanks to our return bag system, is the most economical."

Says Henry Bundt (left), poultryman of Lebanon, N. J., "I get my feed at the Hunterdon G.L.F. in *burlap bags.* Then I return the empties and get credit for each. Our feed bags are tossed in the truck, dragged around and carted out to the chicken houses. Burlap bags can sure take rough handling."

For operating efficiency burlap bags save time and trouble. For economy, a return bag system is *the key to lower feed costs.* If there is no return bag plan in your area write to The Burlap Council, 155 East 44th Street, New York 17, N. Y.

Published by THE BURLAP COUNCIL of the Indian Jute Mills Association

NEW BULLETINS

Handling Apples in Bulk Boxes by H. P. Gaston and J. H. Levin. Michigan Agricultural Experiment Station Special Bulletin 409 (April, 1956). The bulletin reports on a study in the use of handling apples in bulk boxes as a follow-up on work done in a previous study of fruit handling with fork-lift trucks.

The 20-page bulletin lists the advantages of the bulk box method to the grower, the processor, the trucker, and to the industry. It describes construction of the bulk box and how bulk boxes are used in handling windfall apples, cull apples, processing apples, and apples to be sold as fresh fruit. It also describes the type of equipment that is necessary by both processors and growers, in the bulk handling of apples. In conclusion it points out the limitations of the method as well. Copies may be obtained by writing to the Bulletin Room, Michigan State University, East Lansing, Michigan.

Feed-Handling Equipment by J. E. Dixon and J. W. Martin. Pacific Northwest Cooperative Extension Bulletin No. 12 (April, 1956). The 12-page, 8½ x 11-in, bulletin contains illustrations and descriptions of the latest feed-handling equipment including self-unloading wagons, trucks and feeders, portable elevators, augers, blowers, elevating equipment feeders, conveyors and bunk feeders, upright silo unloaders, and other feed handling equipment. One section of the booklet is also devoted to feed-handling principles.

The Six-Inch Water Tunnel at the St. Anthony Falls Hydraulic Laboratory and Its Experimental Use in Cavitation Design Studies by Lorenz G. Straub, John F. Ripken, and Reuben M. Olson. University of Minnesota, St. Anthony Falls Hydraulic Laboratory, Technical Paper No. 16, Series B (March, 1956). The 22-page bulletin is a mimeograph of a paper presented at the National Physical Laboratory Symposium on Cavitation in Hydrodynamics at Teddington, Middlesex, England, September 14-17, 1955. The paper reports on a circulating model water tunnel devised for the purpose of determining prototype design data for use in the planning of various types of cavitation test facilities. It describes the basic tunnel, the critical cavitation tests made on the tunnel, and some cavitation studies made in the tunnel.

Environmental Physiology and Shelter Engineering with Special Reference to Domestic Animals. Missouri Agricultural Experiment Station (Columbia).

XXXV. Heat and Moisture Removed by a Dairy Stable Ventilation System During Diurnal Temperature Rhythms, by R. G. Yeck. Research Bulletin 595 (December, 1955). The purpose of the bulletin is to present data on the heat and moisture exchange that can be expected in a dairy barn under variable temperature conditions; to present data on a diurnal change in stable heat and moisture dissipation which in turn can be correlated with diurnal heat and moisture production of the animals; and to present detailed data on the test room environmental condition as a companion to other research bulletins in this series. All bulletins in this series report on the broad objective of determining the effect of environment on cattle in order to establish building design and animal selection criteria.

XXXVII Moisture Vaporization by Jersey and Holstein Cows During Diurnal Temperature Cycles as Measured with a Hygrometric Tent by R. G. Yeck and H. H. Kibler. Research Bulletin 600 (February, 1956). This bulletin reports a unique method for direct determination of the total vaporization rate. No metabolic measurements were required and the apparatus was used inside one of the test rooms. The hygrometric tent used for measuring the total vaporization rate of cattle is a plastic canopy or tent of sufficient size to enclose a 1500-lb cow. The moisture content of both the intake and the exhaust air can be measured.

NIAE Bulletins. The following bulletins have been received recently from the National Institute of Agricultural Engineering, Wrest Park, Silsoe, Bedfordshire, England:

A Study of the Effect of Dirt and Damage on Potatoes in Storage—Technical Memorandum No. 127.

A Study of Some of the Factors Affecting the Manual Separation of Potatoes and Rubbish on a Conveyor—Technical Memorandum No. 128.

The Effect of Drum Setting and Crop Moisture Content on the Germination of Combine Harvested Barley—Report No. 56.

The Farm Drying of Crops—Reprinted from *The Industrial Heating Engineer* (London), October, 1954 to June, 1955.

Agricultural and Horticultural Engineering Abstracts—Abstracts from World Literature, Vol. VII, 1956, No. 2. This report contains over 300 abstracts in 18 subjects.

ROCKFORD

This is the Clutch that the nations largest manufacturers of heavy-duty machines are showing as a NEW feature

*TRADE MARK

"MORLIFE clutch has gone 851 hours without slipping or adjustment."

"MORLIFE clutch going strong after 1695 hours, working in sand."

"MORLIFE clutches last 950 hours longer, without adjustment."

"MORLIFE clutch needs adjustment once a month, instead of daily."

"MORLIFE requires lighter handle pull and one tenth the adjustments."

"MORLIFE pulls harder and lasts six to ten times longer."

"Won't buy a unit that isn't equipped with Durable MORLIFE clutch."

New **MORLIFE* CLUTCHES and CLUTCH PLATES Give—**

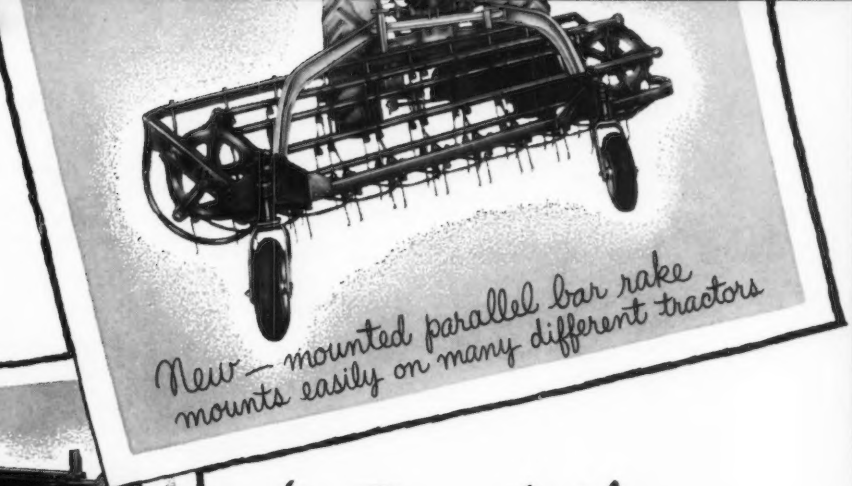
MORE Clutch Life (400% MORE)
MORE Torque Capacity (100% MORE)
MORE Heat Resistance (50% MORE)

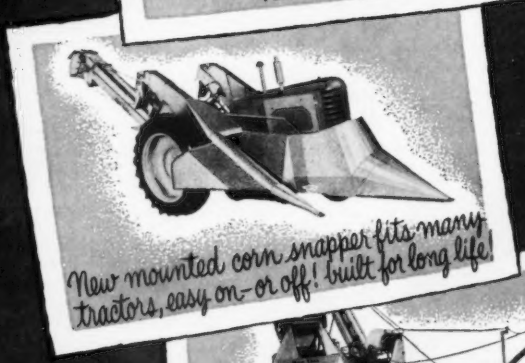
These *new* ROCKFORD Clutches and Clutch Plates have been developed by ROCKFORD Clutch Engineers to take full advantage of recently discovered facing material. Actual field tests on heavy duty equipment have resulted in adoption of MORLIFE clutches by builders of tractors, earth movers, graders, shovels, cranes, trucks, oil field equipment and power units. For information how these *new* Rockford MORLIFE Clutches will improve the operation and increase on-the-job hours of heavy duty machines, write Department E.

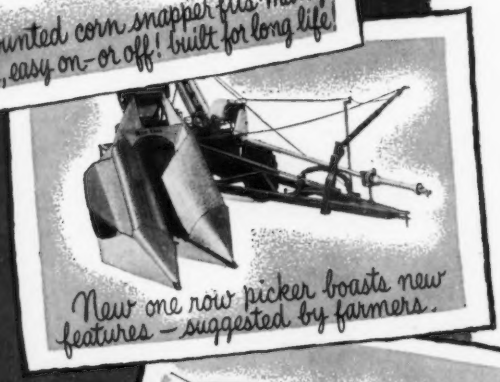
ROCKFORD Clutch Division BORG-WARNER

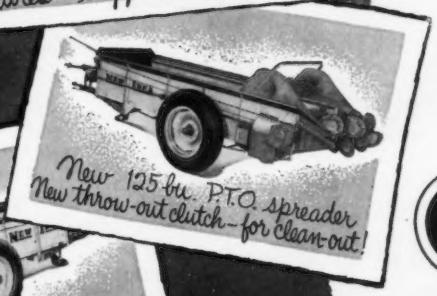
1325 Eighteenth Avenue, Rockford, Illinois, U.S.A.

CLUTCHES









"Candidly—

...we think these newest NEW IDEAS are the GREATEST EVER!"

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The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Bailey, Walter C. — Supervisor, Reyburn Mfg. Co. (Mail) 2504 Hillside Lane, Norristown, Pa.

Balog, Daniel Z. — Farm planner and technician, Soil Conservation Service (Mail) 600 No. Logan St., Lansing, Mich.

Best, William A. — Engineer, John Deere Tractor Co. (Mail) 214 West Elm, Stillwater, Okla.

Compton, Henry J. — Drainage contractor, RR 2, South Haven, Mich.

Curtis, Donald R. — Sales engineer, Lufkin Foundry & Machine Co. (Mail) Box 237, Floresville, Tex.

Daum, Donald R.—Graduate assistant, Pennsylvania State University (Mail) 305 Burrows St., State College, Pa.

DelFavero, Richard R. — Graduate student, University of Connecticut, Storrs, Conn.

Frisby, James C. — Engineering trainee, Caterpillar Tractor Co., Peoria, Ill. (Mail) Y.M.C.A., 714 Hamilton

Gaskill, Ellerton F. — Student, University of Minnesota (Mail) 2800 Lakeview Ave., St. Paul, Minn.

Guy, Kenneth H., Jr. — Assistant zone manager, International Harvester Co., Buffalo, N. Y. (Mail) 95 Theodore St.

Harrell, James O. — Patent examiner, U. S. Patent Office, Washington, D. C. (Mail) 120 Oak Drive, Terrell, Texas

Harriott, Billie L. — Engineering trainee, International Harvester Co., Rock Falls, Ill. (Mail) Apt. 109, 606 West LeFevre, Sterling, Ill.

Henry, Edwin K. — Junior engineer, Firestone Tire & Rubber Co., Akron, Ohio (Mail) RR 4, Connersville, Ind.

Jenkins, Arlie J. — Mechanical engineer, Timken Roller Bearing Co., 1835 Dueber Ave. S.W., Canton, Ohio

Johnson, Billy J.—Trainee in maintenance, Ralston-Purina Co. (Mail) 4719 Panola St., Ft. Worth, Texas

Johnson, Clayton C. — Engineering trainee, Caterpillar Tractor Co., Peoria, Ill. (Mail) Aurelia, Iowa

Johnson, Ian M. — Lecturer in agricultural engineering, Egerton College, P.O. Njoro, Kenya Colony, British East Africa

Kallaus, Lonnie J. — Chief, engineering specifications, International Harvester Co., East Moline Works (Mail) RR 1, Davenport, Iowa.

Kuether, Donald O. — Student, University of Minnesota (Mail) Wells, Minn.

Long, Roderick W. — Sales engineer, Corner Motor Sales Ltd., Delhi, Ontario, Canada

MacKenzie, Hugh J. — Junior design engineer, International Harvester Co. of Canada, Ltd. (Mail) 11 Colwyn Road, Toronto 18, Ont., Canada

Meisel, Arieh—Graduate research assistant, Iowa State College, Ames, Iowa

Paine, Myron D. — Student, agricultural engineering, University of Illinois, Urbana, Illinois

Parish, Franklin J. — Head, division of agricultural mechanics, Kemptville Agricultural School (Mail) Box 315, Kemptville, Ontario, Canada

Replogle, John A. — Engineering trainee, U. S. Soil Conservation Service, Urbana, Ill. (Mail) RR 4, Charleston, Ill.

Sherman, George L. — State conservation engineer, U. S. Dept. of Agriculture (Mail) 3428 Leonard St., Raleigh, N. C.

Smith, Harley L. — Sales manager, Pacific Supply Cooperative (Mail) Box 1004, Walla Walla, Wash.

Schoemaker, Willis G.—Student, University of Minnesota (Mail) RR 1, Kasota, Minn.

Schurr, George J. — Agricultural engineer, Soil Conservation Service, USDA (Mail) 1707 I St., Belleville, Kans.

Weitzel, James E. — Test engineer, International Harvester Co., East Moline Works (Mail) Laketon, Ind.

Whitney, Philip A. — Territorial manager, John Deere Plow Co., Portland, Ore. (Mail) Route 2, Box 243, Grandview, Wash.

Wilde, Alfred W. — Student, University of Illinois (Mail) RR 1, Valmeyer, Ill.

Zelevinsky, Dan—Engineer, N. Feldman & Son, Tel-Aviv, Israel (Mail) 44 Acad-Haam St., Tel-Aviv, Israel

Transfer of Membership

Ferguson, James E. — Vice-president and general manager, Southern Irrigation Co., Memphis, Tenn. (Mail) 241 E. Trigg Ave. (Associate Member to Member)

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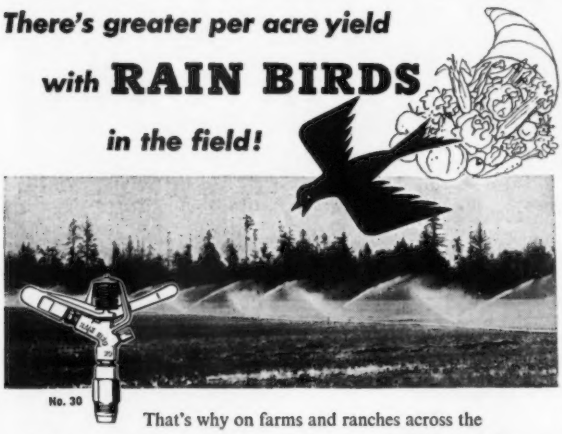

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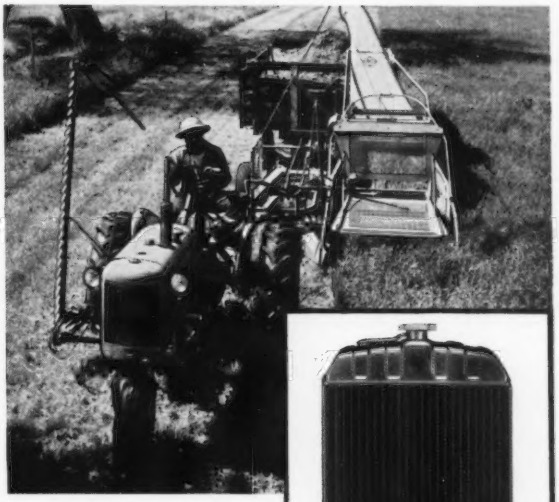

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PERSONNEL SERVICE BULLETIN

NOTE: In this bulletin the following listings current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated. "Agricultural Engineer" as used in these listings is not intended to imply any specific level of proficiency or registration as a professional engineer. Items published herein are summaries of mimeographed listings carried in the Personnel Service, copies of which will be furnished on request. To be listed in this Bulletin, request form for Personnel Service Listing.

POSITIONS OPEN — 1956 — JANUARY — O-534-790. FEBRUARY — O-4-602, 6-603, 12-604, 15-605, 29-606. MARCH — O-60-608, 60-609, 71-611, 80-612. APRIL — O-115-614, 117-615, 117-616, 119-617, 127-618. MAY — O-133-620, 155-621. JUNE — O-164-622, 165-623, 166-624, 166-625, 167-626, 159-627, 142-628, 173-629, 175-630, 179-631, 181-632, 181-633.

POSITIONS WANTED—1955—DECEMBER—W-489-58, 480-59. 1956—JANUARY—W-457-60, 528-61, 529-62. FEBRUARY—W-8-1, 18-5, 30-6, 37-7. APRIL—W-50-11, 101-12, 90-13, 96-14, 43-15, 53-16. MAY—W-125-17, 139-18, 143-19. JUNE—W-161-20, 149-21, 122-22.

NEW POSITIONS OPEN

AGRICULTURAL ENGINEERS, also mechanical and electrical (several) for work in product research, design and development of farm implements, farm tractors, industrial power tractors and road building equipment. Product design, design analysis, research, stress analysis, laboratory and field testing. Large manufacturer. Midwest locations. Age 20-40. BS or MS deg in agricultural or mechanical engineering or MS in electrical engineering, with mathematics thru calculus and machine design courses. Farm background and design and testing experience desirable but not essential. Ability to work with others and desire to work with agricultural implements and farm tractors. Variety of excellent opportunities for able and ambitious men. Salary open. O-183-634

AGRICULTURAL ENGINEER (instructor) to teach farm structures and farm utilities to agricultural engineering students, and service courses in farm shop, farm machinery, and possibly soil and water conservation, at a land grant college in the Southwest. MS deg in agricultural engineering or equivalent, with special interest and study in farm structures and utilities preferred. BS deg in field with good scholastic record and experience may be acceptable. Provision for hospitalization, life insurance and retirement, including Social Security. Opening effective September 1. Regular semesters plus 8 weeks summer teaching. Salary $5244 minimum to start. O-189-635

ASSOCIATE EDITOR for trade publication in farm equipment field, to make repair time studies on tractors as basis for flat rate charge scales, write repair procedure and reference manuals, etc. Travel about 15 percent of time. Midwest location. Age under 50. Working knowledge of farm equipment and some actual service experience. Time study and repair procedure knowledge essential. Writing ability and some camera experience helpful. Established publisher. Group insurance, pension plan, etc. Salary open but not less than $350 per month to start. O-180-636

IRRIGATION ENGINEER for extension work in soil-water relationships, pump plant installations, water measurement, distribution systems, land preparation and leveling, application rates, etc., in a Southwestern state. BS deg in agricultural, irrigation or civil engineering with major in soil-water applications from recognized engineering school. Farm background and previous professional experience in irrigation. Liking and ability to work with associates and farm people. Opening to be filled as soon as possible. Salary $6500. O-198-637

AGRICULTURAL ENGINEER, assistant extension agricultural engineer rating, for work as farm building plan service specialist in a Southeastern state. Age 20-30. BS deg in agricultural engineering with major interest in farm structures. Neat, agreeable, cooperative, and able to meet public. Excellent opportunity to qualify for more advanced extension work or job in industry. Opening available immediately. Salary $4800 to start. O-215-638

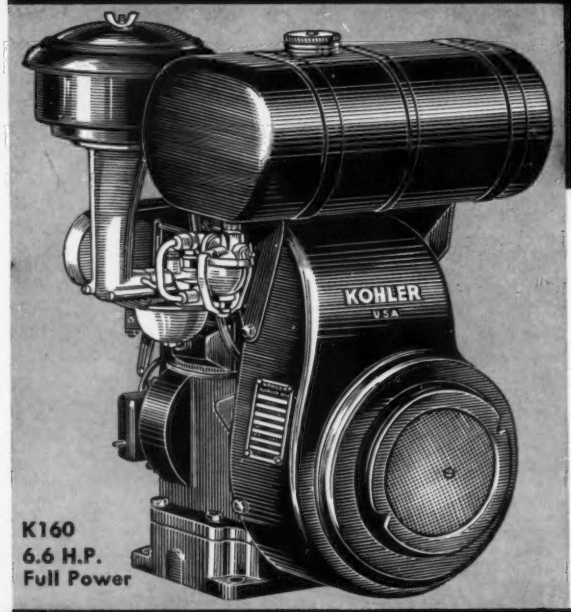
AGRICULTURAL ENGINEER for a position in the Agricultural Experiment Station of southwestern university with the equivalent rating of the academic title of assistant professor. Work will be in irrigation and soil-water-plant relations. Academic training with a master's degree in either agricultural or civil engineering preferred. A minimum of 2 to 3 years practical experience is extremely desirable. Salary commensurate with training and experience. O-216-639

NEW POSITIONS WANTED

AGRICULTURAL ENGINEER for design, development, service, writing or management in power and machinery or product processing field, with manufacturer, processor, or distributor, preferably in northern California. Married. No disability. BS deg in engineering agriculture, 1955, California State Polytechnic College. Student foreman and mechanic, 2 yrs. Assistant engineer in tractor engineering hydraulic section of major manufacturer, 15 mo. Service in U.S. Marine Corps 18 mo. including duty in Korea and Japan. Available on 3 weeks notice. Salary open. W-190-23

AGRICULTURAL ENGINEER for extension, teaching, or research in power and machinery or farm structures field, with public service agency. Any location. Married. Age 35. No disability. BS deg in agricultural engineering, 1949, Clemson College. Expect MS deg in agricultural engineering in August, University of Georgia. Assistant County Agent 5 yr. Experience as manager and operator of a farm in Southeast, and in custom work with farm machinery. Service in U. S. Navy and Naval Reserve 2½ yr, as radar operator. Available Aug. 1. Salary open. W-193-24

AGRICULTURAL ENGINEER for sales, service, or development in power and machinery field with manufacturer, distributor or consultant in USA or Latin America. Married. Age 31. No disability. BS deg in agricultural engineering 1948, University of Illinois. Experience as agricultural engineer, assistant export sales engineer, special equipment engineer and special equipment manager in export sale of farm equipment. War service in Naval Aviation Cadet Corps and Naval Air Corps 2½ yr. Available now. Salary open. W-214-25



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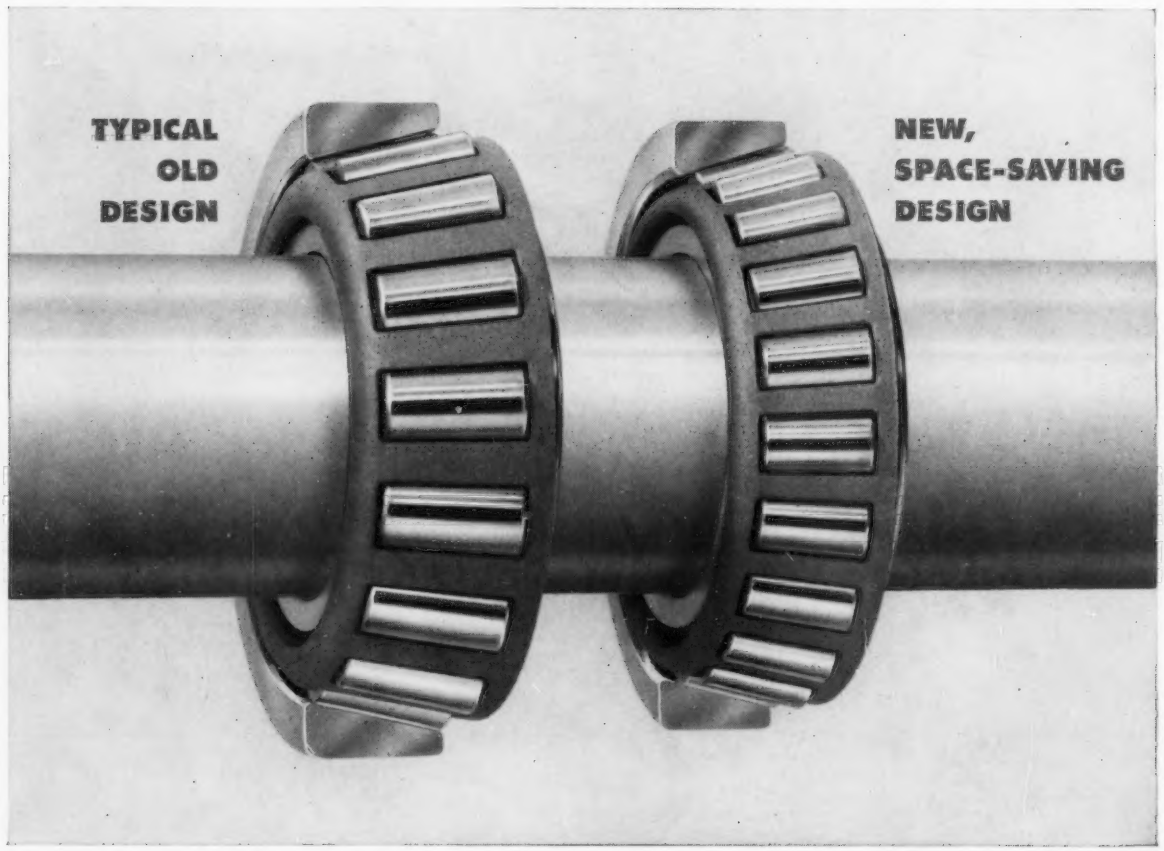

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